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Vol. 2, No. 10 Abstracts 2-2455 to 2-2775 October 1960

CONTENTS

SERIALS

The following list gives in full the abbreviated citations used after the titles of papers in this issue of GeoScience Abstracts.

Akademiya Nauk SSSR, Izvestiya, Geologic Series, in English translation (American Geological Institute). Washington, D.C.
Alabama Academy of Science, Journal. Montevallo.
American Association of Petroleum Geologists, Bulletin. Tulsa, Oklahoma.
American Ceramic Society, Journal. Easton, Pennsylvania.
American Mineralogist (Mineralogical Society of America). Ann Arbor, Michigan.
American Society for Testing Materials, ASTM Special Technical Publication. Philadelphia.
American Society of Civil Engineers, Hydraulics Division, Journal. Ann Arbor, Michigan.
Américas (Pan American Union, General Secretariat of the Organization of American States). Washington, D.C.
Arizona Highways. Phoenix.
Brigham Young University, Dept. of Geology, Brigham Young University Research Studies, Geology Series. Provo, Utah.
California, Dept. of Water Resources, Bulletin. [Sacramento?].
Canada, Geological Survey, Geophysics Paper. Ottawa.
Canadian Mining Journal. Gardenvale, Quebec.
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Chemical and Engineering News (American Chemical Society). Easton, Pennsylvania.
Chicago, Natural History Museum, Fieldiana: Geology.
Colorado School of Mines, Quarterly. Golden.
Columbia University, Dept. of Geology, Technical Report. New York.
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Evolution (Society for the Study of Evolution). Lancaster, Pennsylvania.
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Geochimica et Cosmochimica Acta. London-New York.
Geological Society of America, Bulletin. New York.
Harvard University, Museum of Comparative Zoology, Bulletin. Cambridge, Massachusetts.
Illinois State Geological Survey, Circular. Urbana.
Indiana Academy of Science, Proceedings. Indianapolis.
International Geology Review (American Geological Institute). Washington, D.C.
Iowa State University, Engineering Experiment Station, Bulletin. Ames.
Journal of Geophysical Research. Washington, D.C.
Kansas, State Geological Survey, Bulletin. Lawrence.
Michigan University, Museum of Paleontology, Contributions. Ann Arbor.
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Mining World. Bristol, Connecticut.
New Hampshire State Planning and Development Commission, Mineral Resources Survey. Concord.
New York Academy of Sciences, Annals; Transactions. New York.
North Dakota Geological Survey, Bulletin. Grand Forks.
Oil and Gas Journal. Tulsa, Oklahoma.
Oil in Canada. Winnipeg, Manitoba.
Oilweek. Calgary, Alberta.
Oklahoma Geological Survey, Bulletin. Norman.
Ontario, Dept. of Mines, Provisional Map. Toronto.
Petroleum Engineer. Dallas, Texas.
Revue Canadienne de Géographie. Montreal.
Rocky Mountain Oil Reporter. Denver, Colorado.
Saskatchewan, Dept. of Mineral Resources, Report. Regina.
Science. Washington, D.C.
Scientific American. New York.
Smithsonian Institution, Smithsonian Miscellaneous Collections. Washington, D.C.
Southern California Academy of Sciences, Bulletin. Los Angeles.
Surveying and Mapping (American Congress on Surveying and Mapping). Washington, D.C.
Texas, Board of Water Engineers, Bulletin. Austin.
U.S. Atomic Energy Commission, [Publication]. Oak Ridge, Tennessee.
U.S. Geological Survey, Bulletin; Circular; Mineral Investigations Map; Professional Paper; Reports, Open-File Series; Water-Supply Paper. Washington, D.C.
Utah Geological and Mineralogical Survey, Bulletin. Salt Lake City.
World Petroleum. New York.

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GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

See also: Mineral Deposits 2-2680.

2-2455. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 822, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 47°15'-47°30'N., long. 64°-64°30'W., 1960.

2-2456. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 823, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 47°30'-47°45'N., long. 64°-64°30'W., 1960.

2-2457. Canada, Geological Survey. CAPE TORMENTINE, WESTMORLAND, PRINCE AND QUEENS COUNTIES, NEW BRUNSWICK AND PRINCE EDWARD ISLAND: Its: Geophysics Paper 826, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°-46°15'N., long. 63°30'-64°W., 1960.

2-2458. Canada, Geological Survey. CARAQUET, GLOUCESTER COUNTY, NEW BRUNSWICK: Its: Geophysics Paper 816, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 47°45'-48°N., long. 64°30'-65°W., 1960.

2-2459. Canada, Geological Survey. MISCOU ISLAND, GLOUCESTER COUNTY, NEW BRUNSWICK: Its: Geophysics Paper 824, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 47°45'-48°N., long. 64°-64°30'W., 1960.

2-2460. Canada, Geological Survey. PORT ELGIN, WESTMORLAND COUNTY, NEW BRUNSWICK: Its: Geophysics Paper 817, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°-46°15'N., long. 64°-64°30'W., 1960.

2-2461. Canada, Geological Survey. TRACADIE, GLOUCESTER COUNTY, NEW BRUNSWICK: Its: Geophysics Paper 815, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 47°30'-47°45'N., long. 64°30'-65°W., 1960.

2-2462. Canada, Geological Survey. PUGWASH, CUMBERLAND COUNTY, NOVA SCOTIA: Its: Geophysics Paper 825, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 45°45'-46°N., long. 63°30'-64°W., 1960.

2-2463. Thomson, Robert. [GEOLOGICAL MAP SHEETS OF VICINITY OF COBALT, ONTARIO]: 6 sheets: 5 map sheets, legend sheet, Ontario, Dept. Mines, Provisional Maps P-61, P-62, P-63, P-64, and P-65, scale 1 in. to 400 ft., 1960.

These uncolored geological map sheets (white prints) are part of group of maps to be issued for the Cobalt region. These 5 maps cover parts of Lorrain Township, district of Temiskaming: Map P-61 (Con. 11 & 12), Map P-62 (Con. 9 & 10, lots 1-6), Map P-63 (Con. 9, lots 7, 8, 9; Con. 10, lots 7, 8), Map P-64 (Con. 7, lots 7-12; Con. 8, lots 7-10), Map P-65 (Con. 7 & 8, lots 1-6).

2-2464. Canada, Geological Survey. BIRCH LAKE, KENORA DISTRICT, ONTARIO: Its: Geophysics Paper 883, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1,000 gammas, lat. 51°15'-51°30'N., long. 92°-92°30'W., 1960.

2-2465. Canada, Geological Survey. CARILLON LAKE, KENORA DISTRICT, ONTARIO: Its: Geophysics Paper 884, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1,000 gammas, lat. 51°30'-51°45'N., long. 92°-92°30'W., 1960.

2-2466. Canada, Geological Survey. JEANETTE LAKE, KENORA DISTRICT, ONTARIO: Its: Geophysics Paper 882, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1,000 gammas, lat. 51°-51°15'N., long. 92°-92°30'W., 1960.

2-2467. Canada, Geological Survey. LAUGHTON LAKE, KENORA DISTRICT, ONTARIO: Its: Geophysics Paper 887, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1,000 gammas, lat. 52°15'-52°30'N., long. 92°-92°30'W., 1960.

2-2468. Canada, Geological Survey. McCOY LAKE, KENORA DISTRICT, ONTARIO: Its: Geophysics Paper 888, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1,000 gammas, lat. 52°30'-52°45'N., long. 92°-92°30'W., 1960.

2-2469. Canada, Geological Survey. NABIMINA LAKE, KENORA DISTRICT, ONTARIO: Its: Geophysics Paper 886, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1,000 gammas, lat. 52°-52°15'N., long. 92°-92°30'W., 1960.

2-2470. Canada, Geological Survey. PAPAONGO LAKE, KENORA DISTRICT, ONTARIO: Its: Geophysics Paper 881, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1,000 gammas, lat. 50°45'-51°N., long. 92°-92°30'W., 1960.

2-2471. Canada, Geological Survey. PETOWNIKIP LAKE, KENORA DISTRICT, ONTARIO: Its: Geophysics Paper 889, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1,000 gammas, lat. 52°45'-53°N., long. 92°-92°30'W., 1960.

2-2472. Canada, Geological Survey. WAPESI LAKE, KENORA DISTRICT, ONTARIO: Its: Geophysics Paper 880, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1,000 gammas, lat. 50°30'-50°45'N., long. 92°-92°30'W., 1960.

2-2473. Canada, Geological Survey. WIGWASIKAK LAKE, KENORA DISTRICT, ONTARIO: Its: Geophysics Paper 885, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1,000 gammas, lat. 51°45'-52°N., long. 92°-92°30'W., 1960.

2-2474. Canada, Geological Survey. CAPE EGMONT, PRINCE COUNTY, PRINCE EDWARD ISLAND: Its: Geophysics Paper 818, aeromagnetic

map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°15'-46°30'N., long. 64°-64°30'W., 1960.

2-2475. Canada, Geological Survey. NORTH POINT, PRINCE COUNTY, PRINCE EDWARD ISLAND: Its: Geophysics Paper 821, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 47°-47°15'N., long. 64°-64°30'W., 1960.

2-2476. Canada, Geological Survey. O'LEARY, PRINCE COUNTY, PRINCE EDWARD ISLAND: Its: Geophysics Paper 819, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°30'-46°45'N., long. 64°-64°30'W., 1960.

2-2477. Canada, Geological Survey. TIGNISH, PRINCE COUNTY, PRINCE EDWARD ISLAND: Its: Geophysics Paper 820, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°45'-47°N., long. 64°-64°30'W., 1960.

2-2478. Stose, George W., and O. A. Ljungstedt, comps. GEOLOGIC MAP OF THE UNITED STATES: 4 sheets, scale 1:2,500,000, Washington, D.C., U.S. Geological Survey, 1932, reprinted 1960.

2-2479. Yates, Robert G., and A. E. Ford. PRELIMINARY GEOLOGIC MAP OF THE DEEP LAKE QUADRANGLE, STEVENS AND PEND OREILLE COUNTIES, WASHINGTON: U.S. Geol. Survey, Mineral Inv. Map MF-237, scale 1:24,000, contour interval 40 ft., lat. 48°45'-48°52'30"N., long. 117°30'-117°37'30"W., 1960.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Geomorphology 2-2503; Geohydrology 2-2668, 2-2671, 2-2672, 2-2673, 2-2679; Mineral Deposits 2-2694, 2-2709.

2-2480. Blackadar, Robert G. PRECAMBRIAN GEOLOGY OF THE ARCTIC ISLANDS: Can. Mining Jour., v. 81, no. 4, p. 108-110, Apr. 1960.

Geologic features of the Arctic archipelago are similar to those on the mainland. Generally, the rocks are progressively younger from the SE. to the NW. Magnetic data are in accord with the progressive thickening of post-Precambrian rocks toward the NW. The broad division of the Precambrian rocks on the shield into gneisses, granitic rocks, highly deformed sedimentary material, and slightly metamorphosed sedimentary strata, is equally applicable in the Arctic archipelago.

Although current economic interest is directed toward oil exploration, some attention has been given to metallic minerals. Reported occurrences of economic minerals include graphite, magnetite, soapstone, sphalerite, galena and pyrite.--W. C. Peters.

2-2481. Lehmann, Elroy P. THE BEDROCK GEOLOGY OF THE MIDDLETOWN QUADRANGE WITH MAP: Connecticut, Geol. & Nat. History Survey, Quad. Rept. no. 8, 40 p., 6 illus., 3 maps (2 maps in pocket incl. col. geol. map, scale 1:24,000), secs. (in pocket), table, 1959, 55 refs.

The Middletown quadrangle is principally underlain by Triassic rocks of the Newark group, but a small area of pre-Triassic Bolton schist is exposed SE. of the eastern Border fault, which crosses the SE. corner of the map area. In this area the Newark group is divided into 7 formations which in geochronologic order are as follows: New Haven arkose, Talcott basalt, Shuttle Meadow formation, Holyoke basalt, East Berlin formation, Hampden basalt, and Portland arkose. Of these formational names, Shuttle Meadow and East Berlin are new.

With the exception of the New Haven arkose, all the formations of the Newark group are well exposed within the quadrangle. The weaker sedimentary rock units generally underlie the valleys; they are mainly gray-red, but the Shuttle Meadow and East Berlin formations each contain one or more gray to black mudstone and shale sequences. The coarser Portland arkose (principally arkose and granule to pebble conglomerate) ranges in color from gray and gray-green to red-brown. Syngenetic sedimentary structures of various types are described from all the sedimentary formations of the Newark. A preliminary study of paleostream senses within the area suggest that an intensive study of all paleostream indicators, as well as other paleogradient indicators such as tilted pipe vesicles at the base of the basalts, on a regional and stratigraphic basis may be useful in providing data on the Triassic sedimentary patterns and environments.

The basalt formations of the Newark group are the topographically prominent units of the Triassic and are abundantly exposed along the scarp faces of structurally controlled ridges. The basalts are fine grained, gray to green- or blue-gray in color, vesicular and amygdaloidal near the upper surfaces of the flows, and exhibit in varying degree the structures commonly found in basaltic lava flows (e.g., pillows, columnar jointing).

Structurally the Newark group rocks are a homoclinal prism dipping about 15° to the ESE. The homocline is cut by numerous faults, which are predominantly oblique normal faults, with the downthrown side mostly on the NW., although conjugate normal faults appear to be present also. Strike-slip faults are exposed in some outcrops of basalt, whereas some outcrops of sedimentary rocks show evidence for bedding-plane faults. A gently plunging anticlinal structure with very small vertical closure is inferred in the area on the basis of the map pattern. Jointing is well developed in some parts of the quadrangle; generally 3 sets compose the joint system. The general agreement of the orientation of the joint system in the quadrangle with the joint systems observed in 2 areas to the E. and SE. in the pre-Triassic rocks suggests that a careful analysis of jointing on a regional basis might yield significant information on the tectonic history of the region.--Auth.

2-2482. Lemke, Richard W. GEOLOGY OF THE SOURIS RIVER AREA, NORTH DAKOTA: U.S. Geol. Survey, Prof. Paper 325, 138 p., 15 illus., 9 maps (6 in pocket incl. 2 col., scale 1:96,000), 11 secs., 2 diags., 1960, 94 refs.

The Souris River area comprises about 5,500 sq. mi. in N.-central North Dakota. Most of the area is mantled with surficial deposits, chiefly of Pleistocene age. Rocks of Late Cretaceous and Tertiary age underlie the surficial deposits and crop out locally.

The Pierre shale, Fox Hills sandstone, and possibly the Hell Creek formation, all of Late Cretaceous age, directly underlie the surficial deposits in the eastern part of the area. Elsewhere, Tertiary rocks consisting of the Cannonball and Tongue River

pers of the Fort Union formation of Paleocene re the uppermost bedrock.
ne Pleistocene deposits are Wisconsin in age, except for a few deposits along the valley of the Lacs River, all are believed to belong to the ato substage of glaciation. These deposits have divided into the following geologic units: Max ine, ground moraine, overridden ice-contact sits, linear-ridge deposits, diversion-channel sits, river terrace deposits, kames and eskers, noraines in the Souris loop area, ice-marginal ash-channel deposits, glaciofluvial deposits un-rentiated, and deposits of glacial Lake Souris. ese, ground moraine is the most widespread

ecent deposits are landslides, dune sand, and ium. Large landslides are abundant along the y walls and tributaries of the Des Lacs River. sand is confined mostly to the glacial Lake is area.
ost of the area is believed to lie in a broad, ow syncline that trends NW. into Canada. Min-resources include lignite, petroleum, gas, con-ction materials, sodium sulfate, and clay.--Auth.

83. Baldwin, Ewart M. GEOLOGY OF ORE-: 136 p., 38 illus., 15 maps, 6 charts, 6 secs., files, 2 diags., Eugene, Oregon, 1959, approx. efs.

he study presented is concerned mainly with the rical geology of Oregon, with its succession of a and formations, and their ages as determined ssils and relative position. A brief resume of e aspects of physical and historical geology is n. Where possible, technical terms are avoided a simplified version is given. The geology is ussed regionally following the physiographic di-ns outlined by Dicken who divided Oregon into ollowing areas: Coast Range, Willamette Valley, ades, Klamath Mountains, Deschutes-Umatilla au, Blue Mountains, High Lava Plains, Basin-e, and Owyhee Uplands. Some of these like the n-Range area are part of a much larger and well recognized physiographic province. Others rank as subprovinces but there is no attempt to determine formal status and they are referred to less formally as areas. Frequent reference is made to geologic time divisions.--From auth. introd.

2-2484. Barosh, Patrick James. BEAVER LAKE MOUNTAINS, BEAVER COUNTY, UTAH - THEIR GEOLOGY AND ORE DEPOSITS: Utah Geol. & Mineralog. Survey, Bull. 68, 89 p., 16 illus., 3 maps (1 col.), 6 secs., March 1960, 51 refs.

The Beaver Lake Mountains lie in the Basin and Range province of W.-central Utah, 10 mi. NW. of the town of Milford, Beaver County.

Paleozoic sediments and Tertiary igneous rocks are found in the area. Lower to Middle Cambrian rocks form a transgressive sequence of quartzite, shale, and carbonates. The later Middle Cambrian to the Late Ordovician has no representatives in the area, but the latest Ordovician(?) to the Devonian is represented by a dolomite sequence. This sequence is overlain by Mississippian limestone. No sedimentary rocks younger than Mississippian have been recognized in the area.

The early(?) Tertiary is represented by volcanics, which are generally quartz latite in composition, and some granodiorite porphyry. These were followed in the middle(?) Tertiary by a quartz monzonite intrusion which has altered part of the earlier carbonates and volcanics.

Structurally the area is complex and can be divided into 2 parts; the northern third which has been effected by high-angle faulting, thrust faulting, and folding, and the southern two-thirds in which the structure mainly reflects the shape of the intrusion with some modification by high-angle faulting.

The geologic record of the area appears to be one of relatively quiet sedimentation for the early and middle Paleozoic, which probably continued until the late Mesozoic although no record of the latter part of this period is present, and a great deal of activity in the latest Mesozoic and Tertiary with extrusion, intrusion, thrusting, folding, and high-angle faulting. --Auth.

2. GEOMORPHOLOGY

lso: Structural Geology 2-2513; Stratigraphy 3; Geophysics 2-2593; Sedimentary Petrology 7; Engineering Geology 2-2763, 2-2764.

85. Gosselink, John G. WHAT CAUSED THE AGE?: Indiana Acad. Sci., Proc., v. 68, p. 297, 1958, pub. 1959, 7 refs.

is possible that long range climatic variations be a product of temperature fluctuations result-rom changes in the water vapor content of the 's atmosphere, and hence from changes in the nhouse effect." The cycle postulated in this r should develop conditions of unstable equilibri-t both ends of the fluctuation, and should cause limate to change very rapidly during the period the equilibrium became upset. At the warm f the cycle the climate should warm up very ly when the last of polar ice disappears. This y seems corroborated by evidence from ocean m sediment cores. The nature of marine life in the cores indicates that the change in climate have been exceedingly sharp, and the sharp f demarcation indicates that the change must been extremely sudden.--From auth.

2-2486. Laverdière, Camille, and Albert Courtemanche. LA GÉOMORPHOLOGIE GLACIAIRE DE LA RÉGION DU MONT TREMBLANT [THE GLACIAL GEOMORPHOLOGY OF THE MONT TREMBLANT REGION]: Rev. Can. Géographie, v. 13, no. 3/4, p. 102-134, 3 illus., 6 maps, sec., table, July-Dec. 1959, 77 refs.; text in French, abs. in French and English.

Though the Mont-Tremblant region comprises the highest summits of the western Laurentians (960 m.), it also comprises vast areas of depression (240 m.). The authors attribute these unevennesses, as well as the great differences of altitude throughout the Laurentians, to a warping tectonic. Contrary to Blanchard and Osborne, they can find no trace in the landscape of terraced erosion surface (peneplains). The bayonet-shaped outline of the streams, determined by the structure of the bedrock, directed the glacial flow, which is responsible for the major relief. In the low valleys of the Laurentians, the Champlain transgression immediately followed the glaciation, whose final phase, in the region under study, was able to be dated at 8,200 years. The climatic conditions since that time, revealed by

palynological studies, are divided into 5 major periods, each characterized by a different forest covering. Lastly, an absence of periglacial phenomena is noted.--Auth.

2-2487. Efimtsev, N.A. THE QUATERNARY GLACIATION IN WESTERN TUVA AND THE EASTERN PART OF THE GORNY ALTAY: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 9, p. 52-71, 2 illus., 2 maps, 3 secs., profile, 3 tables, pub. May 1960, 33 refs.

This article presents a preliminary regional stratigraphic subdivision of the Quaternary deposits of western Tuva and the eastern part of the Gorny Altay, with a brief account of the supporting data. Features of past glacial history are analyzed, and the conditions under which the fluvioglacial deposits form are examined.--Auth.

The basic features of topography of W. Tuva and the eastern part of Gorny Altay are inherited from Eopleistocene times. Differential uplift occurred after the formation of Miocene carboniferous sedimentary deposits. The traces of glaciation showed that it occurred in the second half of the middle Pleistocene epoch and that no substantial changes have since occurred. During the dissipation of the ice sheet, large glaciers were formed in many places, and this explains the formation of numerous kames, eskers and moraines. The author believes that only one glaciation period occurred in the region. Various terrace formations of boulders and rock waste found in the region were caused by the action of numerous streams and rivers formed by the melting glaciers and cannot be considered as remains of earlier glaciations. In this the author disagrees with almost all other geologists who worked in the region.--LC.

2-2488. Thomas, Charles W. LATE PLEISTOCENE AND RECENT LIMITS OF THE ROSS ICE SHELF: Jour. Geophys. Research, v. 65, no. 6, p. 1789-1792, 2 secs., 3 tables, June 1960, 6 refs.

Investigation of ocean-bottom cores in polar regions has shown that strata lacking in skeletal remains of organisms are an indication of conditions during which a snow cover on sea ice prevented the transmission of short-wave radiation from atmosphere to sea water. The presence of organic remains, on the other hand, is indicative of 'warm' periods during which solar energy was available for photosynthesis by holophytic plankton.

In this paper results of examination of 2 cores from the S. edge of the Ross Sea are reported. The cores have been correlated with horizons dated by the C-14 method. The presence in the sediments of volcanic ash deposited by the wind at times when perennial sea ice blanketed the region is puzzling. Calculation of rates of penetration of sedimentary material under conditions of a cold environment discloses the mechanism of bottom sedimentation through sea ice with a snow cover.

The evidence of the sediments indicates that the Ross ice shelf has not advanced materially beyond its present northerly limits during late Pleistocene and Recent time.--Auth.

2-2489. Saint-Onge, Denis. NOTE SUR L'ÉROSION DU GYPSE EN CLIMAT PÉRIGLACIAIRE [NOTE ON THE EROSION OF GYPSUM IN A PERIGLACIAL CLIMATE]: Rev. Can. Géographie, v. 13, no. 3/4, p. 155-162, 5 illus., map, July-Dec. 1959, 13 refs.; text in French, abs. in French and English.

Five gypsum diapirs pierce the Mesozoic sedi tary rocks of Ellef Ringnes island. One of these, Isachsen dome, was visited by the author in May Under either temperate or warm and humid clima gypsum is generally associated with low-relief k features. On Ellef Ringnes island, however, the gypsum domes rise to 125 m. above the low plain It seems that under the present periglacial morph climatic conditions now prevailing on the island, permafrost, the low rainfall, the absence of chem erosion, and the low frost-shattering index of gyp combine to make gypsum a very resistant rock.-- Auth.

2-2490. Morisawa, Marie E. RELATION OF QUANTITATIVE GEOMORPHOLOGY TO STREAM FLOW IN REPRESENTATIVE WATERSHEDS OF APPALACHIAN PLATEAU PROVINCE: Columbia Univ., Dept. Geology, Tech. Rept. no. 20, 94 p. 17 maps, profile, 29 diags., 19 tables, 1959, 33

Geometry of 15 watersheds in the Appalachian Plateau province conforms to Horton's laws of dr age composition in horizontal, or planimetric pro erties, but not in vertical, or relief properties. Geologic structure and varying lithology act to ch vertical form elements, causing deviations from Horton's laws.

Geometric similarities and differences in wate shed morphology provide both quantitative and qua tative bases for grouping the regions studied into distinct sections. Dissimilarities, though distinc are not great.

Simple correlations of hydrologic and geomorp logic features provide the basis for choice of cha acteristics to use in a multiple regression on peal runoff intensity. A regression of peak intensity o runoff on basin area, rainfall intensity and freque and topography has a high correlation coefficient is significant at the .001 level. Quantitative dete minations of geomorphic properties of drainage basins thus have a practical use in basin hydrolog --Auth.

2-2491. Leopold, Luna B., and M. Gordon Wol RIVER MEANDERS: Geol. Soc. America, Bull. 71, no. 6, p. 769-793, 2 illus., 2 maps, 3 secs. diags., table, June 1960, 47 refs.; abs. in Engli French, German, and Russian.

Most river curves have nearly the same value the ratio of curvature radius to channel width, in range of 2 to 3. Meanders formed by meltwater the surface of glaciers, and by the main current the Gulf Stream, have a relation of meander leng to channel width similar to rivers. Because such meanders carry no sediment, the shapes of curv in rivers are evidently determined primarily by dynamics of flow rather than by relation to debri load.

Velocity distributions along river curves prov a generalized picture of flow characteristics. E dence on flow resistance in curved channels sugge that a basic aspect of meander mechanics may be related to the distribution of energy loss provide by a particular configuration or curvature. No g eral theory of meanders is as yet satisfactory, h ever; in fact, present evidence suggests that no gle theory will explain the formation and charact istics of all meanders and that few of the physica principles involved have yet been clearly identifi --Auth.

2-2492. Gurnee, Russell H. THE STREAM TH BRIDGED THE RIVER: Américas, v. 12, no. 7,

34, 6 illus., sec., July 1960.

Semúc is a natural bridge across the Cahabón
er, Alta Verapaz, Guatemala, formed by the pre-
tation of calcareous tufa from cave waters enter-
the main river. The bridge has a free span of
t. on the upstream side and 196 ft. on the down-
eam side; it is from 60 to 80 ft. thick and extends
r the Cahabón River for 1,610 ft. The bridge car-
s the stream from which its limestone was de-
ited to a point on the downstream side of the bridge
re it enters the Cahabón River in a free fall.--
Russell.

493. Kes, A.S. FLUCTUATIONS OF THE
AL SEA LEVEL. Prepared by U.S. Joint Publica-
s Research Service: Internat. Geology Rev., v.
o. 7, p. 623-627, 2 illus., map, profile, July
0, 4 refs.

The Aral sea (approx. 45°N.-60°E.), outlet basin
he Amu-Darya and Syr-Darya rivers, is similar
ther basins enclosed by a desert area in that its
el is very unstable. In the past, these rivers
e been inconstant in the amount and direction of
ir flow; and, thus, have played a considerable role
he sea-level fluctuation. Evidence of former,
her sea levels of the Aral is indicated by its ter-
es, composed of sea sedimentation. The highest
race is composed of gray sand, and shells of the
llusk Cardium edule. Below this, there occurs
econd terrace of light blue-gray carbonate loam;
er terraces of solonchak (salt marsh) extend to
Aral shoreline. Maximum elevation of past sea-
els, according to terrace elevations, was approx.
to 57 m.

Occurrence of freshwater mollusk shells of Ano-
ta with those of Cardium edule found in situ in
ivial deposits along the downstream channels of
Zhana-Darya river, indicate the frequent changes
regime of the Aral sea. The maximum level of
transgression probably occurred in the northern
al region about 3,000 B.C.; this was based on dis-
ution of Cardium edule and of sites of the primi-
e Celtaminarian peoples. These same sites in the
theastern Aral region indicate the maximum to
e occurred from 700 to 1,000 B.C. In recent
rs, the highest level recorded for the Aral was
m. in 1956; the lowest, 51.5 m., in 1920.

The sea-level fluctuation curve for the Aral sea
in opposition to that of the Caspian, but in agree-
nt with that of lake Balkhash. Opposition of the
al and Caspian fluctuation curves probably results
m intensification of glacier melting during periods
drought, thus swelling the Amu-Darya and Syr-
rya rivers and, consequently, raising the Aral
level. Aral sea-level fluctuations result from
istic changes in climate of long duration through-
considerable areal extent and depend on factors
sative of glacier ablation where meltwaters drain
o rivers that feed the Aral sea.--D.D. Fisher.

2494. Terasmae, Jaan, and Robert J. Mott.
TES ON SAND DUNES NEAR PRESCOTT, ONTAR-
Rev. Can. Géographie, v. 13, no. 3/4, p. 135-
1, 5 illus., diag., 2 graphs, July-Dec. 1959, 9
s.; abs. in English and French.

Numerous parabola dunes were discovered during
reconnaissance of the St. Lawrence Seaway Pro-
t area near Prescott, Ontario. A study of their
siography and structure showed that these dunes
re formed by winds from the E. Other dunes
med in post-glacial time in Ontario and Quebec
indicate wind direction from the W., thus posing an interesting problem. Palynological studies, coupled with radiocarbon dating indicate that these dunes were formed about 8,000 to 9,500 years ago, when the level of the Champlain Sea stood about 100 to 110 m. above the present sea level.--Auth.

2-2495. Visher, Stephen S. INDIANA'S VALLEYS: Indiana Acad. Sci., Proc., v. 68, p. 292-293, 1958, pub. 1959.

Indiana has several kinds of valleys ranging in size from sinkholes and kettle holes to the section of the state which comprises a part of the great Mississippi valley. The deepest is the valley in which Lake Michigan lies, 600 ft. from top of dunes to bottom of lake. Mechanism of valley formation includes solution of underlying limestone, irregular deposition of glacial material, runoff, wind erosion, slumping, and man-made features. Valleys are drainage ways, obstacles to transportation, sites of roads and railroads, and sources of water supply.--M. Russell.

2-2496. Bailey, G.W., and Joe L. White. THE MINERALOGY AND GENESIS OF A SOIL (TILSIT SILT LOAM) OF THE UNGLACIATED REGION OF INDIANA: Indiana Acad. Aci., Proc., v. 68, p. 337-342, 2 secs., table, 1958, pub. 1959, 7 refs.

The soils of Indiana have been formed from a variety of parent materials which include glacial tills, sedimentary rocks, and loess.

In a study of the influence of parent material on soil genesis in the unglaciated area, a Tilsit silt loam profile was sampled on a site underlain by the Borden group. This group consists primarily of sandstones and siltstones. The Tilsit silt loam is a (III) profile, has moderately slow surface drainage, is moderately well drained internally, and occurs on 2-4% slopes. The Tilsit belongs to the Zanesville catena and is characterized by the presence of a fragipan.--Auth.

2-2497. Ulrich, H.P. WISCONSIN MORAINES AS A SOURCE OF LOESS IN SOIL FORMATION IN FAYETTE AND UNION COUNTIES: Indiana Acad. Sci., Proc., v. 68, p. 349-353, 2 figs. incl. map, table, 1958, pub. 1959, 2 refs.

An opportunity to study the relationship of Wisconsin moraines to loess deposition in an area where glacial meltwater river valleys are narrow and would be expected to contribute little loess was afforded by completed soil surveys of Fayette and Union counties, Indiana. Moraines such as the Champaign and Shelbyville contributed to a relatively thick silt mantle on the eastward side near the moraine and probably to a smaller increment widely distributed over more distant areas.--M. Russell.

2-2498. Gooding, Ansel M., and Erling E. Gamble. LEACHED, CLAY-ENRICHED ZONES IN POST-SANGAMON DRIFT IN SOUTHWESTERN OHIO AND SOUTHEASTERN INDIANA: NEW OBSERVATIONS AND DATA: Geol. Soc. America, Bull., v. 71, no. 4, p. 511-514, Apr. 1960, 15 refs.

Recently evidence has been presented demonstrating that leached, clay-enriched zones in outwash beneath calcareous till, widespread in southwestern Ohio and southeastern Indiana, are not paleosols but are instead downward extensions of the surface soil through cracks and joints in the overlying till [see

GeoScience Abstracts 1-1892, 1-1893]. Interpretation of these clay-enriched, leached zones as ancient soils has led to erroneous conclusions about the Pleistocene history of this area. The authors believe the present evidence does not support the interpretation of a post-Sangamon - pre-classical Wisconsin glaciation and soil-forming interval in this region. Two similar pseudo buried soils, outside the Ohio-Indiana area, are described which the present writers believe support their conclusions. In addition, C^{14} age determinations on colloidal organic material in the pseudo buried soils suggests that the organic material in the dated zones is entirely of post-till age. --B.W. Pipkin.

2-2499. Bascom, Willard. BEACHES: Sci. American, v. 203, no. 2, p. 80-92, 94, 9 illus., 2 maps, 2 secs., Aug. 1960.

Beaches are discussed in terms of their continual motion. Beaches, the area between the permanent coast and about 30 ft. below water level, are constantly in motion onshore and offshore, and along shore. Their composition is described and the energy which does the moving is discussed in terms of waves and currents. Illustrations of beach profiles and of water and particle motion during long-shore transfer of sand are given.

The technique of making beach profiles is described in some detail. Certain conclusions are drawn from the profiles and other measurements made; for example, steeper beaches in general are composed of larger sand grains than gentle beaches, although degree of protection from swell and other factors must be considered. Seasonal onshore and offshore motion of sand results in an exchange between the offshore sand bars and the horizontal upper beach deposit or berm.

Certain annual cycles are covered in some detail, and such beach features as rip channels, cusps, and ripple marks are also discussed. Beach conservation is a major problem along many coasts where the continual motion of sand builds some beaches and destroys others. Illustrations from the California and New York-New Jersey coasts are given to demonstrate the effect of breakwaters, groins, and other conservation methods in stabilization of shorelines.--R.F. McAllister.

2-2500. Lyon, C.J., and W. Harrison. RATES OF SUBMERGENCE OF COASTAL NEW ENGLAND AND ACADIA: Science, v. 132, no. 3422, p. 295-296, diag., July 29, 1960, 9 refs.

Altitudinal and C-14 age determinations of in-place Pinus strobus stumps of drowned forests at Odiorne Point, New Hampshire, and Grand Pré and Fort Lawrence, Nova Scotia, yield apparent average rates of submergence of 3.1, 14.5, and 20.3 ft. per 1,000 C-14 years, respectively. Rate differences are assessed in terms of eustatic rise of sea level, crustal movements, and tidal effects.--Auth.

2-2501. Vermeer, Donald E. THE CAYS OF BRITISH HONDURAS: 127 p., 30 illus., 11 maps, profile, 2 diags., Berkeley, University of California, Dept. of Geography, 1959, 41 refs.

Numerous coral islands or cays constitute a conspicuous element of the Caribbean Sea margin of British Honduras S. of Chetumal. The first part of this study is a description of the cay regions and cays and a classification of the latter, preceded by a brief outline of the geology and geomorphology o British Honduras. Three kinds of cay are recogni 1) the coral sand cay, 2) the mangrove cay, and 3 the mangrove-sand cay or transition type cay. Ea of the cay regions is described in some detail as i a cay of each of the types.

The second part attempts an explanation of the origin and distribution of the cays. Sand cays are simple in outline and consist of a mass of coral sa piled up by wind and waves; some have vegetation others do not. Mangrove cays consist of mangrov trees, Rhizophora, rooted in shoal banks of sand o mud. The mangrove-sand cay consists of sand an mangrove, the proportion of each varying with deg of exposure. The refraction of waves around the reef to stop material being driven across the reef a significant factor in cay development. The limit of coral growth to the southern portion is the resu of an eddy current preventing the usual upwelling cold waters.--M. Russell.

2-2502. Gibson, William M. SUBMARINE TOPO GRAPHY IN THE GULF OF ALASKA: Geol. Soc. America, Bull., v. 71, no. 7, p. 1087-1107, map fold. chart, 11 profiles, July 1960, 26 refs.

A bathymetric chart of the Gulf of Alaska and a proaches covering an area of about 800,000 square nautical miles has been prepared from Coast and Geodetic Survey hydrography, 1925-1957, with a view to defining regional physiographic provinces.

The basic data comprise 90 sounding lines acro the gulf, 42,000 mi. of graphically recorded profil obtained during the last 5 years, and detailed surveys of 60 seamounts, seaknolls, and ridges. Ten tative names are assigned principal features of the sea floor to facilitate discussion.

The bathymetry and illustrated profiles reveal clearly the form of the Aleutian trench, 2 submari mountains, several seamount chains and groups, a ridge and trough province, a 200-mi. trench W. o Vancouver Island, a great trough paralleling the West Coast, and an inferred fracture zone extendi in several wide echelon bands across the gulf.

The submarine topography is discussed in relat to existing theories of earth science and correlate with features previously mapped on the mainland a in the central Pacific Ocean.--Auth.

2-2503. Fisher, Robert L., and Robert M. Nor BATHYMETRY AND GEOLOGY OF SALA Y GOM SOUTHEAST PACIFIC: Geol. Soc. America, Bull v. 71, no. 4, p. 497-502, 2 illus., 3 maps, Apr. 1960, 7 refs.

Sala Y Gomez is a low volcanic islet at 26°27'4 105°28'W. It is approximately 700 m. long (E.-W. and 400 m. wide. Members of the University of C fornia, International Geophysical Year Expedition "Downwind," spent one day systematically investi ing the island and adjacent platform area.

The island is related to an E.-W. structural tr that may extend from 1,200 km. W. of Easter Isla eastward beyond San Felix and San Ambrosio near the Chilean coast. It is suggested that the portion the submarine ridge, from Sala Y Gomez eastwar to at least 90°W. long., be designated the Sala Y Gomez ridge. Similarities between this ridge and Clipperton ridge in the northeastern Pacific sugge that Sala Y Gomez ridge is a part of another "frac zone," such as those described in the NE. Pacific. There is a well-defined shelf break surrounding t island at between 119-121 m. The uniformity of t

ak suggests little or no tilting of the platform
ce its formation.
Three distinct rock units are exposed on the islet.
e lowermost is a vesicular red to dark-gray an-
tic olivine basalt. The middle unit is a coquina
posed mostly of fragments of mollusk shells,
aminifera, echinoid spines, and corals. This
is discontinuous and not more than 1 m. thick.
rlying the middle unit is a vesicular to dense an-
tic olivine basalt. Although the organic remains
so badly leached that a reliable age determination
difficult, the freshness of the lava flows suggests
eistocene or Recent age.--B.W. Pipkin.

504. Robitaille, Benoît. APERÇU GEOMOR-
OLOGIQUE DE LA RIVE QUÉBÉCOISE DU DÉ-
DIT D'HUDSON [GEOMORPHIC OBSERVATION ON THE QUEBEC SHORE OF HUDSON STRAIT]: Rev. Can. Géographie, v. 13, no. 3/4, p. 147-154, 3 illus., map, July-Dec. 1959, refs.; text in French, abs. in French and English.

The text deals with some general aspects of the geomorphology of a portion of the southern shore of Hudson Strait, between Cape Wolstenholme and Wakeham Bay. Deep valleys indenting this coast are interpreted as having been formed prior to Pliocene times. The whole area was glaciated during the Pleistocene. The morphological evidence of glaciation and post-glacial submergence is studied. Since deglaciation, a periglacial system of erosion has prevailed. The main effects introduced by this system are considered and it is concluded that the present-day periglacial processes are not very dynamic in the area.--Auth.

3. STRUCTURAL GEOLOGY

also: Stratigraphy 2-2534; Geophysics 2-2604, 606, 2-2609; Igneous and Metamorphic Petrology 648, 2-2650; Mineral Deposits 2-2691.

2505. Brace, William F. BEHAVIOR OF ROCK LT, LIMESTONE, AND ANHYDRITE DURING DENTATION: Jour. Geophys. Research, v. 65, 6, p. 1773-1788, 12 illus., 7 diags., 2 tables, e 1960, 27 refs.

The indentation hardness test is being investigated a means of studying the behavior of rock under ess sufficiently great to be of geologic interest. his study, indentation and compression of a lime-ne, marble, anhydrite, and artificial rock salt compared. Indentation of these rocks with a 136° amidal indenter produces an approximately hemi-erical deformed zone beneath the surface indenta-n. Within this zone the average microscopic char-er of the rock is similar to that deformed in com-ession tests at low to moderate confining pressure room temperature. In detail, the deformation of rock salt is predominantly due to gliding; both gle grains and rock work-hardened just under the enter. The deformation of the other rocks was to a combination of gliding and microfracturing. smuch as translation gliding in the calcite, as wn by coloration during X-irradiation, occurred spite of abundant fractures formed at the same ne, large frictional forces must have developed surfaces of fractures and along grain boundaries. Approximate stress and strain fields were found the deformed zone, from which average values stress difference, confining pressure, and strain uld be determined. These 3 quantities agreed rly well with a point on a stress-strain curve ob-ned from a confined compression test of a cylinder the same material. Vickers hardness is 3 ± 0.3 nes the compressive stress difference which is en at a confining pressure of 1/6 of the hardness strain of $7(\pm 5)\%$.
At present, the greatest use of the indentation rdness in geology is in comparative studies of the ength of nonporous, crystalline, relatively iso-pic rocks.--Auth.

2506. Pavlovsky, E.V. PRECAMBRIAN AND WER PALEOZOIC HISTORY OF THE SCOTTISH GHLANDS AND THE ROLE OF ABYSSAL FRAC-RES: Akad. Nauk SSSR, Izvestiya, Geol. Ser., translation, 1958, no. 7, p. 1-16, 5 maps, 2 secs., le, pub. Apr. 1960, 50 refs.

On the basis of his review of the Precambrian and lower Paleozoic, given in a preceding paper [Geo-Science Abstracts 2-1683], the author analyzes the structural development of Scotland during this time and describes the role of abyssal fractures. The basement of the Eria platform, the Lewisian complex, is described as a 2-cycle or possibly polycycle complex involving at least 2 distinct structural units. The lower unit of the basement of the Eria platform is composed of sedimentary and igneous rocks metamorphosed at a great depth and folds of NE. strike. The upper unit is composed of rocks metamorphosed under different thermodynamic conditions and is cut by basic and ultrabasic dikes and granitic intrusions. The end of this stage was marked by strongly compressed NW.-trending folds and overthrusts.

During Precambrian and Cambrian time Scotland was broken up by faults into a series of successively depressed blocks, regulating the development of geosynclinal zones. The Moine geosyncline apparently had its greatest extent SE. of the Eria platform bounded by the Moine abyssal fault. At the start of the Dalradian (Riphaean, upper Sparagmite) the Great Glen abyssal fault cut the Northern Highlands from the Moine miogeosyncline and converted it into a marginal uplift. The effect was to change the Moinian geosyncline regime into an eugeosynclinal regime lasting through the Cambrian. At the start of Ordovician, the Boundary fault cut off an area of the Cambrian eugeosyncline - the Central Lowlands and Southern Uplands. The Grampian Highlands became a marginal uplift.

From the Middle Ordovician on, the faulted blocks, except for the Eria platform, were spasmodically folded and intruded. Schists were formed, and the structure of the ancient Moine faulting became a complex system of overthrusts overlapping the edges of the platform.

During the Devonian, a vast zeugogeosyncline formed on the epi-Caledonian platform, lying mostly within the present North Sea and adjacent Atlantic Ocean. "Apophyses" of this extended into Scotland in the form of synclines and intermont basins controlled by the Great Glen and Boundary faults.--T.H. W. Loomis.

2-2507. Panov, D.G. TYPES OF DEEP FAULTS ON THE BOTTOMS OF THE OCEANS: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 9, p. 72-75, pub. May 1960, 22 refs.

Investigations have shown the importance of the

role played by deep faults in the formation of major structural differences in the earth's crust. Two types of deep faults may be distinguished on ocean bottoms: 1) faults in the area of the continental slope; 2) faults in the bottoms of ocean basins. Examples are given of open and concealed faults on the continental slope. Faults in the bottoms of ocean basins are associated with abyssal plains, ridges, and abyssal trenches. They are marked by greater extent and more recent tectonic activity than deep faults in the continents.--A. C. Sangree.

2-2508. Laubscher, Hans P. ROLE OF FLUID PRESSURE IN MECHANICS OF OVERTHRUST FAULTING: Geol. Soc. America, Bull., v. 71, no. 5, p. 611-615, May 1960, 6 refs.

From whatever angle the writer looks at the problem of the effect of pore pressure on the mechanics of porous rocks he finds himself in agreement with Terzaghi's view: the force of uplift due to pore pressure is proportional to surface porosity. To explain experimental evidence that along shear fractures the surface porosity is equal to unity, he proposes to consider the fact that surface porosity increases during development of the fracture. The Archimedes principle should not be applied to porous rocks underground.--Auth. concl.

2-2509. Hubbert, M. King, and William W. Rubey. ROLE OF FLUID PRESSURE IN MECHANICS OF OVERTHRUST FAULTING: A REPLY: Geol. Soc. America, Bull., v. 71, no. 5, p. 617-628, 4 illus., 5 diags., May 1960, 6 refs.

In the light of the critic's objections to the authors' earlier analysis of the buoyancy effect and other aspects of the mechanics of fluid-filled porous rocks, the authors have seriously reexamined the problem. As a result of this reexamination they find themselves in complete agreement with Terzaghi's resolution of the total stress field in a fluid-filled porous rock into a neutral and effective component, where the neutral stress is equal at every point to the fluid pressure p as macroscopically determined. They do not agree, however, with the equation for the buoyancy effect of this neutral component, or that the buoyancy in any manner depends upon the fractional surface porosity.

While, in the authors' opinion, the equation for the force of buoyancy is erroneous, its widespread use in soil mechanics and in other branches of civil engineering does not ordinarily lead to erroneous results because in practice it is found necessary to assign to surface porosity the value of unity in order to make the equation agree with experimental data. When this is done the equation reduces to the correct result. The authors merely wish to reiterate that, had the theory been valid in the first place, this expedient would not have become necessary.--B. W. Pipkin.

2-2510. Lowe, Kurt E. STRUCTURE OF THE PALISADES INTRUSION AT HAVERSTRAW AND WEST NYACK, N. Y.: New York Acad. Sci., Annals, v. 80, art. 4, p. 1127-1139, 7 illus., 2 secs., 1959, 8 refs.

Information presented in this paper is admittedly inconclusive, but may serve to corroborate the basic concepts of Darton and Kümmel. The sum total of the available evidence suggests to the author that the outer rim of the sickle-shaped Palisades ridge is a low-angle semicircular dike gradually transgressing sediments of the Newark group having equally low dips. Along the inner margin (backslope) of the ri the sheetlike intrusion appears to steepen rather abruptly into a semicircular feeder dike dipping 40 to 50° toward the "center" of the "sickle." Geome rically, this structure could be likened to the rim one half of a flaring funnel, somewhat reminiscent of the shape postulated for the Cortlandt Complex intrusive, except that it would be "hollow" in the center.--Auth. concl.

2-2511. Thompson, Henry D. THE PALISADES RIDGE IN ROCKLAND COUNTY, N. Y.: New York Acad. Sci., Annals, v. 80, art. 4, p. 1106-1126, 7 illus., map, 4 secs., 1959, 8 refs.

The structural relations of that part of the Pali sades ridge, consisting of a Triassic diabase intru sive, which lies in Rockland County, New York is discussed.

The base of the sill is in general concordant wit the sediments, and its abrupt vertical offsets are to faults rather than to stratigraphic migration.

With a change in direction of dip from W. to S., the westward swing of the diabase from Haverstraw to Mt. Ivy continues as a sill, rather than as a dik that rises gradually, or intermittently, across the structure.

Where the upper contact of the diabase and the sediments on the back slope of the Palisades is not concordant, the contact is that of a normal fault rather than that of a feeder dike.

The notches, or gaps, in the ridge have been etch out by weathering, mass wasting, and rill erosion along zones weakened by faulting, rather than by th corrasion of fortuitously superposed, through-flow streams.--From auth. concl.

2-2512. Buldakov, V. V. SOME PECULIARITIES OF THE STRUCTURE OF THE MAYTAS GRANITE MASSIF (IN THE NORTHERN PRIBALKHASH ARE AND THE DISTRIBUTION OF CERTAIN RARE EL MENTS IN IT: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 9, p. 18-27, 2 ma pub. May 1960, 10 refs.

The Maytas granite massif, situated in the N. B hash region, is formed of different layers of effus and sedimentary rocks, which can be divided into series: lower-sedimentary, middle-effusive, and upper-effusive sedimentary. The massif, an elon gated unconforming intrusive body, is broken up b a system of fissures extending in all directions. These fissures appeared when the upper parts of t massif hardened. Some fissures are of radial dir tion and others of concentric direction. These co centric dislocations served as entrances for the m matic material as well as for later magmatic solu tions. Granites formed during these 2 periods ar of 3 varieties - coarse-grained biotites, medium- and fine -grained porphyritic leucocratic granites. The first 2 granites are characteristic of the mai intrusive phase, and the last belongs to the secon phase and is represented by vein granites. Differ rare element ores were found in these granites. spectral and chemical analyses some rules were established for these elements. The amount of M W, and Be in the later leucocratic granites is muc larger than in the earlier granites. All 3 element were most frequently found in granites subjected t secondary transformations. It means that the hig est concentration of these elements occurred in th late magmatic phase. In contrast to this, Sr and were generally found in the coarse-grained granit

ne early, main intrusive phase.--LC.

513. Norton, James J., and Jack A. Redden. RUCTURE ASSOCIATED WITH ROCK CREEP IN E BLACK HILLS, SOUTH DAKOTA: Geol. Soc. erica, Bull., v. 71, no. 7, p. 1109-1111, 3 illus., ., July 1960, 2 refs.

Many areas of schist in the southern Black Hills, th Dakota, have a thin zone of disintegrated rock is 4-10 ft. below the ground surface and parallel t. Fresh, undeformed schist overlying this zone moved downhill in a mass-wasting process since present surface was formed.--Auth.

514. Worzel, J. Lamar, and Charles L. Drake. RUCTURE SECTION ACROSS THE HUDSON RIVER NYACK, N.Y., FROM SEISMIC OBSERVATIONS: w York Acad. Sci., Annals, v. 80, art. 4, p. 1092-5, map, 8 secs., 1959, 5 refs.

The data from 23 seismic refraction profiles and boreholes made as a part of the preliminary in-tigations of foundation conditions at the Tappan Bridge were combined to construct a structure tion across the Hudson River. Four seismic ho-ons were identified with organic silt, unconsolidated iment, Triassic sedimentary rocks, and the meta-rphic and intrusive rocks of Westchester County. The structure is, in general, that which would be dicted from a study of the geology of the adjacent relines. Although no evidence of a large fault ermining the course of the Hudson River was nd, the possibility of such a fault with a throw of w hundred feet is present. Perhaps the outstand-feature of the section is a buried channel on the side of the river that reaches a depth of about ft. Comparisons with sections at Storm King New York City indicate a reversal in gradient hin this channel. It is suggested that this reversal caused by the Pleistocene ice sheet which covered the area.--Auth. summ. & concl.

2-2515. . Sobolevskaya, V.N. THE FOLDED BASEMENT OF THE URALS PART OF THE WESTERN SIBERIAN SHIELD: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 9, p. 41-51, map, sec., pub. May 1960, 12 refs.

The W. Siberian shield is a part of the Paleozoic Ural-Siberian plateau. Covered by a Mezo-Cenozoic series the shield rests on a basement of dislocated and metamorphosed Paleozoic rocks. The author prepared a relief map of this basement from which it can be seen that this Paleozoic basement is formed in 2 parts: a large terracelike belt along the Ural mountains with an eastern slope, and the other (located in the southeastern corner of the region) a huge, dome-shaped massif, declining in a northerly direction. The first part can be considered as a zone of buried folded basement. The second part is presumably formed by Caledonian and early Hercynian strata. On the border of these 2 basic structural zones, there is a meridional depression, partly filled with volcanogenic and sedimentary rocks of Permian-Triassic age.--LC.

2-2516. Vongaz, L.B. THE PALEOZOIC STRUCTURAL AND FACIES SUBZONES IN THE TURKESTAN-ALAY MOUNTAIN SYSTEM (SOUTHERN TIEN SHAN): Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 8, p. 49-60, 3 maps, chart, pub. May 1960, 6 refs.

English translation of GeoScience Abstracts 1-648.

2-2517. Smirnov, A.M. CONJUNCTION OF THE MONGOL-OKHOTSK AND PACIFIC FOLD ZONES WITH THE CHINA PLATFORM: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 8, p. 61-74, 5 maps, pub. May 1960, 23 refs.

English translation of GeoScience Abstracts 1-647.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

also: Structural Geology 2-2506; Paleontology 2-0, 2-2575, 2-2584, 2-2585; Sedimentary Petrology 0660.

2518. Stokes, William Lee. ESSENTIALS OF RTH HISTORY, AN INTRODUCTION TO HISTORI-L GEOLOGY: 502 p., approx. 400 figs., Engle-od Cliffs, New Jersey, Prentice-Hall, 1960, ap-ox. 100 refs.

A 20-chapter book for use in liberal arts or culture college introductory courses in historical geology. e first 7 chapters deal with methods, principles, d historical development of the subject, stressing ne, superposition, and methods of reconstructing past. Eight chapters are devoted to the develop-nt of the earth and its life forms through pre-logic and geologic time; findings of astronomy, sics, and chemistry are introduced. The treat-nt is of a summary, nondetailed nature; the geo-ic periods are lumped together in natural groups: ecambrian, early Paleozoic, late Paleozoic, Meso-ic, Tertiary, and Pleistocene. The subject is veloped on a world-wide basis with the evolution physical features and life forms summarized for entire earth. Up-to-date information from the est maps and reports of the International Geophys-l Year is included. The text is supported by 12 rld paleogeographic maps based on new publications on previously little-known regions. The last 5 chapters deal more specifically with the relationship of life to the changing physical world; subjects such as origin of life, evolution, adaptation, and extinction are treated from the viewpoint of paleontology.--Auth.

2-2519. Markevich, V.P. THE CONCEPT OF FACIES. Translated by Ivan Mittin: Internat. Geology Rev., v. 2, no. 5, p. 367-379, May 1960; no. 6, p. 498-507, June 1960; no. 7, p. 582-604, July 1960; 17 maps, 3 secs., 2 diags., 55 refs.

In 3 parts. Pt. 1 contains an introduction and Chap. 1. The concept of "facies" in Soviet geologic literature. Pt. 2 is composed of Chap. 2, The concept of "facies" in foreign geologic literature; and Chap. 3, Certain patterns in the distribution of facies. Pt. 3 contains Chap. 4, Definition of the term "facies" and terms related to this concept; and Chap. 5, Some results of the analysis of facies in Miocene and Pliocene deposits of eastern Georgia [U.S.S.R.].

2-2520. Norton, Matthew F. STRATIGRAPHIC POSITION OF THE LOWERRE QUARTZITE: New York Acad. Sci., Annals, v. 80, art. 4, p. 1148-1158, 3 illus., 2 maps, 2 tables, 1959, 10 refs.

The Lowerre quartzite [Precambrian] question is really 2 separate questions: 1) Does the existence of a quartzite on preliminary mapping S. of the Hudson highlands in the presumed sequence - quartzite-metamorphic limestone-schist - mean that these rocks can be correlated with the apparently less metamorphosed quartzite-limestone-phyllite sequence N. of the Hudson highlands. 2) Does it actually exist and if so what is its origin and stratigraphic position. This paper considers primarily the second question and concludes that the quartzite exposures S. of the Hudson highlands do exist; they appear to be of sedimentary origin; and, in light of present evidence, they constitute a bona fide formation. Unless or until future data render these conclusions invalid, the established formation name - Lowerre quartzite - should continue to be applied to them.--M. Russell.

2-2521. Prucha, John James. FIELD RELATIONSHIPS BEARING ON THE AGE OF THE NEW YORK CITY GROUP OF THE MANHATTEN PRONG: New York Acad. Sci., Annals, v. 80, art. 4, p. 1159-1169, 2 maps (1 fold.), table, 1959, 20 refs.

Any attempted age correlation of the New York City group must be consistent with the following points. The Fordham gneiss is not the equivalent of the Precambrian gneisses of the Hudson highlands. It is the conformable basal unit of the New York City group, of which it is an integral and partly interbedded metasedimentary formation. There is no evidence of faulting between the Fordham gneiss and the Inwood marble.

The formations of the New York City group, including the Fordham gneiss, were deformed simultaneously, both in the earlier stage of isoclinal folding and in the latter stage of axial-plane folding. The internal structure elements of the New York City group are consistent among the 3 constituent formations [basal Fordham gneiss overlain by the Inwood marble and the Manhattan formation].

The Cambro-Ordovician sequence N. of the Hudson highlands cannot, as yet, be traced through the Precambrian highlands directly into rocks of the New York City group.

The stratigraphic sequence of the New York City group is not a recognizable facsimile of the sequence in the Cambro-Ordovician rocks N. of the Hudson highlands. The so-called Lowerre quartzite [Precambrian] cannot be considered the equivalent of the Poughquag quartzite unless the former can be demonstrated to be a valid formation. In any case, the Fordham gneiss may not be considered apart from the New York City group, and the Fordham has no recognizable counterpart in the Cambro-Ordovician sequence.

In the absence of datable fossils, the K-Ar method of age determination offers a potential method of solving the problems of correlation in the New York City area.--From auth. summ.

2-2522. Carman, J. Ernest. THE STRATIGRAPHY OF THE DEVONIAN HOLLAND QUARRY SHALE OF OHIO: Chicago, Nat. History Mus., Fieldiana: Geology, v. 14, no. 1, 5 p., sec., table, June 20, 1960, ref.

The Silurian-Devonian disconformity between the Raisin River dolomite and the Sylvania sandstone represents all of Early Devonian (Helderberg-Deerpark) time and the early part of the Middle Devonian (Onesquethaw). During this interval a trench or pit was eroded in the Raisin River dolomite and later filled with black mud sediments in which were incorporated remains of organisms living there at that time and a few grains of quartz sand probably brought to this locality from the N. partly by eolian action. Later in mid-Devonian times a remnant of this black shale protected by its position in the trench or pit in the Raisin River dolomite, was covered by the Sylvania sandstone and a great thickness of middle Paleozoic rocks. Regional erosion during the present cycle and finally the quarry excavation exposed the shale mass. This black shale may have been deposited any time during the Lower Devonian or early part of the Middle Devonian.

Normally a rock unit so small as this shale mass appears to be might not deserve a geologic name, but in consideration of its interesting and unusual fossil it probably should be given a name. The name Holland Quarry shale is here proposed.--Auth. summ.

2-2523. Daniel, Thomas W., Jr., and Earl L. Hastings. FORT PAYNE CHERT-WARSAW LIMESTONE CONTACT IN LIMESTONE COUNTY, ALABAMA: Alabama Acad. Sci., Jour., p. 259-263, map, Apr. 1960, 3 refs.

The Warsaw limestone and St. Louis limestone compose the Tuscumbia limestone of early Mississippian age in all previous Alabama reports. Butts suggested that the Warsaw limestone be mapped as a separate formation when enough detailed work has been done to make the Warsaw easily distinguishable from the underlying Fort Payne chert and the overlying St. Louis limestone.

This study is an attempt to work out some criteria for easy recognition of the Fort Payne chert and Warsaw limetone contact.

According to Butts, "The Fort Payne chert is succeeded, with little or no break, by chert-yielding limestone of different character and with different fossils." No fresh-rock outcrops showing the contact were found in Limestone County.

The mapped contact of the Fort Payne chert and Warsaw limestone in Limestone County is shown.--From auth.

2-2524. Bieber, C.L. SOME MISSISSIPPI LIMESTONE BRECCIAS IN NORTHWEST PUTNAM COUNTY, INDIANA: Indiana Acad. Sci., Proc., v. 68, p. 265-267, map, 1958, pub. 1959, 7 refs.

Differential erosion has exposed an unusual brecciated limestone in a branch of Peters Creek, NW. Putnam County, Indiana. The ledge is 6 ft. thick, composed of rubble breccia at the base, grades upward to a mosaic and then to a crackle breccia. The age is early St. Louis (Mississippian). Subaqueous sliding is favored over storm-wave brecciation as probable means of origin.--M. Russell.

2-2525. Cline, L.M. STRATIGRAPHY OF THE LATE PALEOZOIC ROCKS OF THE OUACHITA MOUNTAINS, OKLAHOMA: Oklahoma Geol. Surv. Bull. 85, 113 p., 2 pls. (in pocket), 28 figs. incl. illus., maps, secs., 1960, refs.

This paper describes some of the stratigraphic features of the Ouachita geosyncline of Oklahoma as they are believed to have been during Late Mississippian and Early Pennsylvanian time. There is considerable evidence that pre-Atoka sediments were deposited in rather deep water. The lithologic characteristics of the Late Mississippian and Early Pennsylvanian Stanley-Jackfork-Johns Valley-Atoka stratigraphic sequence are comparable to the typical bla

shale flysch facies of the Eocene of the Alps and the Eocene and Cretaceous of the Carpathians. The conclusion is reached that a predominantly deep-water dark-shale and radiolarian-chert environment was periodically interrupted by turbidity currents flowing down the steep slopes of the depositional trough and that these currents brought in sands foreign to the black-shale environment. The presence of convolute bedding, graded contacts of sandstones and overlying shales, of abundant flow casts and groove casts on the under surfaces of the sandstones, the general lack of cross-bedding and ripple marks, and the scarcity of fossils except for planktonic and nektonic forms, support this thesis.--Auth.

2-2526. Shutov, V.D. TIME-ROCK SUBDIVISION AND THE CONDITIONS OF DEPOSITION OF PERMIAN AND LOWER TRIASSIC SEDIMENTS OF THE VERKHOYANSK RANGE: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 7, p. 17-36, 5 maps, secs., pub. Apr. 1960, 18 refs.

A scheme of stratigraphic subdivision and correlation of the Permian and Lower Triassic deposits of the Verkhoyansk range is proposed. Five complexes representing stable paragenetic assemblages of facies were deposited in the upper Paleozoic cycle as follows: 1) in lower Permian, Tolchansk and Kygyltass rocks, a lower sand and shale transgressive complex, 2) in lower Permian Echysk rocks, a shale complex characterising maximum transgression and marine stillstand, 3) in upper Permian lower Endybalsk rocks, a flysch complex of early regression, 4) in upper Permian upper Endybalsk rocks, a coal-bearing complex, and 5) in Lower Triassic rocks, a red bed lagoonal-deltaic complex. After deposition, a large part of the area was uplifted. In small areas, continental sands regarded as a separate formation were deposited.--M. Russell.

2-2527. Kossovskaya, A.G. HISTORY OF MESOZOIC SEDIMENTATION IN THE WESTERN VERKHOYANSK RANGE AND THE VILYUY DEPRESSION: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 7, p. 37-57, 4 maps, sec., diag., table, pub. Apr. 1960, 18 refs.

English translation of GeoScience Abstracts 1-654.

2-2528. Nagibina, M.S. STRATIGRAPHY OF THE JURASSIC AND CRETACEOUS DEPOSITS OF THE UPPER BASIN OF THE AMUR RIVER: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 7, p. 58-79, map, secs., 2 tables, pub. Apr. 1960, 11 refs.

This article presents a recapitulation of previous studies of the upper Amur, and establishes a new stratigraphic scheme. According to V.Z. Skorokhod, the Mesozoic deposits of the region could be divided in 2 complexes: maritime and fresh-water continental. The maritime deposits form the following horizons: 1) a basal series of conglomerates and coarse-grained sandstones; 2) Inoceramus zone of sandstones and sandy shales; 3) alternating sandstones and shales; 4) Gervillia sandstones and argillaceous shales; 5) Modiola and variegated sandstones. By the faunal remains, these horizons were classified as belonging to the Upper, Middle and Lower Jurassic. Their over-all thickness is 3.750 m. On these maritime layers the fresh-water continental coal-bearing deposits form the second thick series. These deposits were mainly formed by clastic sediments, representing alternating layers of sandstone conglomerates, aleurolites, argillates, carbonaceous shales and coals, between which interlayers of acid pyroclastic rocks and thin interlayers of felsites were found. The thickness of these layers varies from 3,200 m. to 3,900 m. Study of adjacent regions shows that all these deposits belong to the Upper Jurassic-Lower Cretaceous. Comparison of the stratigraphic profiles of different parts of the Amur river basin shows a large variety of facies and thickness of the fresh-water deposits, which is directly connected with the peculiarities of the tectonic development of the large Mesozoic depressions of the region.--LC.

2-2529. Eliseev, V.I. THE PROBLEM OF THE GENESIS AND THE AGE OF THE DINOSAUR STRATUM IN SOUTHEASTERN BET-PAK-DALA: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 9, p. 75-78, pub. May 1960, 11 refs.

Huge accumulations of broken dinosaur fossils were found in many regions of Central Asia and Kazakhstan, usually in coarse conglomerates. In all these accumulations (except those of Bissekta and of the Tashkent region) the bones were rounded, fissured and eroded. The author concludes that the layers which included these bones originated on seashores. Fossilized remains of marine flora and fauna found in these layers confirm that the fossilization of the bones occurred after their breaking up in zones of sea wave action and that the "dinosaur level" was never transferred from one layer to another. The age of the "dinosaur level" has been placed between the Turonian and Senomanian stages of the Upper Cretaceous. As to the better preserved conditions of the 2 above-mentioned accumulations, it was found that the maritime conditions in those regions continued longer than in other parts. Maritime Paleogene deposits, which covered the Jurassic sediments containing these bones, protected them from erosion, whereas other accumulations were buried in shallow continental clay layers and were subjected to more intensive erosive action.--LC.

2-2530. Hofker, Jan. THE TYPE LOCALITIES OF THE MAESTRICHTIAN (MAESTRICHTIAN CHALK TUFF) AND OF THE MONTIAN (TUFFEAU DE CIPLY, CALCAIRE DE MONS, LAGUNAR, AND LACUSTRE MONTIAN): Jour. Paleontology, v. 34, no. 3, p. 584-588, illus., table, May 1960, 15 refs.

A recent paper by Loeblich & Tappan induced the author to give an account of our recent knowledge about the Maestrichtian-Montian sequence in Holland and Belgium, where these strata were described for the first time. There is considerable doubt as to the correlation of Danian and Paleocene, and the question is discussed whether the so-called planktonic faunal break of Foraminifera is a time-line. Contrarily to Loeblich & Tappan, the author concludes that at least at the type locality of the Maestrichtian of Dumont, the Maestrichtian chalk tuff, this faunal break is found not above but below this zone, at the boundary between the Gulpen chalk and the tuff. Moreover, the Tuffeau de Ciply, the lower Montian of Dewalque, is not the oldest known Paleocene in Holland and Belgium. --Auth.

2-2531. Frankel, Jack Joseph. LATE MESOZOIC AND CENOZOIC EVENTS IN NATAL, SOUTH AFRICA: New York Acad. Sci., Trans., v. 22, no. 8, p. 565-577, 2 illus., map, 6 tables, June 1960, 9 refs.

The Lebombo basalt-rhyolite association and late Karroo contaminated dolerites are discussed. Silicified wood and other plant remains have established the lower Cretaceous age of a continental sequence resting on tilted and eroded Karroo basalts in Zululand. A new occurrence of Miocene sediments points to the possibility of a wider distribution of Tertiary rocks in Zululand than has been previously recognized. The distribution of Quaternary ilmenite-bearing red coastal sands is described and an eolian origin suggested.--Auth. summ.

2-2532. Osipova, A.I. POLEMICAL QUESTIONS CONCERNING LOWER PALEOGENE STRATIGRAPHY IN SOUTHEASTERN CENTRAL ASIA: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 8, p. 75-88, table, pub. May 1960, 39 refs.

English translation of GeoScience Abstracts 1-660.

2-2533. Orr, Phil C. LATE PLEISTOCENE MARINE TERRACES ON SANTA ROSA ISLAND, CALIFORNIA: Geol. Soc. America, Bull., v. 71, no. 7, p. 1113-1119, 2 illus., map, sec., 6 profiles, table, July 1960, 14 refs.

Three wave-cut platforms with their marine and terrestrial fossil-bearing covers are described and named and are shown to be of late Pleistocene age by means of radiocarbon dating.--Auth.

2-2534. Trumpy, Rudolf. PALEOTECTONIC EVOLUTION OF THE CENTRAL AND WESTERN ALPS: Geol. Soc. America, Bull., v. 71, no. 6, p. 843-907, 5 maps (1 fold.), 2 charts, 13 secs. (1 fold.), table, June 1960, 249 refs.; abs. in English, French, German, and Russian.

This paper deals with the general features of Mesozoic and Tertiary rock sequences and paleogeography in the Alps. It seeks to outline the paleotectonic significance of the rocks and to discuss the structural evolution of the Alpine geosyncline up to the main deformation, with special reference to the sector between the rivers Rhine and Durance. Accent is placed on the relative independence of Alpine structures involving the pre-Triassic basement rocks and of cover nappes consisting only of Meozoic and Tertiary formations.

Normal shallow-water deposits of platform or miogeosynclinal type were laid down over the whole area before eugeosynclinal conditions set in. The typical eugeosynclinal sediments in the central, Penninic belt of the Alps are the Schistes lustrés and Bündnerschiefer, with sills and submarine lava flows of basic volcanic rocks (ophiolites). Before metamorphism they consisted mainly of shales and of impure arenaceous and argillaceous limestones. The bathymetric environment of radiolarian cherts and associated rocks is examined, and their deep-water origin is upheld for the Alpine occurrences. Marine polygenic breccias are characteristic of geosynclinal slopes (commonly fault scarps) and not of a particular depth zone. The Alpine Flysch is a particularly significant sediment. Flysch is a thick marine deposit of predominantly detrital rocks, in part turbidites, generally without volcanic rocks, and laid down during compressional deformation of the geosyncline. Of the many different kinds of Flysch some represent transitions to either Bündnerschiefer or Molasse. Essential differences between the early synorogenic Flysch and the later synorogenic to post-orogenic Molasse are listed.

Argand's stimulating embryotectonic theory of the evolution of the geosyncline is outlined and rejected. The Triassic corresponds to a neutral interval, between the Hercynian and Alpine cycles. Early Alpine geosynclinal history was characterized by vertical or tensional movements along normal faults that limited narrow platforms and rapidly subsiding troughs. This tensional deformation weakened in the Late Jurassic, whereupon bottom relief diminished, and "para-oceanic" conditions prevailed over a large part of the Mediterranean realm. New linear welts of compressional origin arose during the Cretaceous and developed into steep island chains limiting the Flysch basins. Gradually the central part of the Alps rose above sea level, and the geosyncline migrated to the N. and W. Here it was finally filled and gave way to the foreland trough in which the Molasse was laid down.

There is no simple, direct, genetic and space relationship between Hercynian structures, fault-bordered platforms and troughs of the earlier geosynclinal phase, island chains and basins of the Flysch phase, and the later nappe structures. Paleogeographical features are commonly short-lived and migratory.--Auth.

2-2535. Long, Leon E., James C. Cobb, and J. Laurence Kulp. ISOTOPIC AGES ON SOME IGNEOUS AND METAMORPHIC ROCKS IN THE VICINITY OF NEW YORK CITY: New York Acad. Sci., Annals, v. 80, art. 4, p. 1140-1147, 2 maps, 5 tables, 1959, 8 refs.

This paper presents some new isotopic age data obtained in the igneous metamorphic complex in the New York City area and attempts to evaluate its meaning in terms of the metamorphic history of the region.

From the present data it is tentatively concluded that the metamorphism of the New Jersey-New York highlands began 1,100-1,200 m.y. ago. Another regional event occurred about 850 m.y. ago which recrystallized the mica in the metamorphic rocks of the entire area, but was not of sufficient magnitude to cause serious chemical alteration of the zircon. The latest recrystallization of Manhattan Prong rocks occurred about 365 m.y. ago; scattered evidence points to a metamorphic history of these rocks prior to that time. NE. of the Hudson River where the highlands have been strongly remetamorphosed in lower Paleozoic time, apparent ages between 1,200 m.y. and 365 m.y. are found.--From auth. concl.

5. PALEONTOLOGY

See also: Stratigraphy 2-2529, 2-2530; Geochemistry 2-2620.

2-2536. Johnson, Ralph Gordon. MODELS AND METHODS FOR ANALYSIS OF THE MODE OF FORMATION OF FOSSIL ASSEMBLAGES: Geol. Soc. America, Bull., v. 71, no. 7, p. 1075-1085, chart, diag., 2 tables, July 1960, 16 refs.

Theoretical aspects of the formation of fossil assemblages are explored for the purpose of obtaining criteria and methods for the reconstruction of circumstances of preservation of shallow-water marine organisms. Models are developed which represent: 1) a death assemblage preserved under conditions of rapid burial; 2) an assemblage preserved in situ

under conditions of gradual accumulation; and 3) an assemblage composed almost entirely of remains transported to the site of burial.

The histories represented by the models influence the following features of fossil assemblages: faunal composition, morphologic composition, density, disassociation of hard parts, fragmentation, surface condition of fossils, chemical and mineralogical composition of fossils, orientation, dispersion, and the texture and structure of the sedimentary aggregate. The expressions of these features indicate that biological criteria are more indicative of the mode of accumulation than physical criteria.

The stretched-line method of sampling provides a means of obtaining objective and repeatable measures of features of the fossil assemblages in place. It is restricted to sediments in which fossils can be recovered readily. A rank-correlation analysis of 11 samples from the Pleistocene Millerton formation of Tomales Bay, California, is given as an example of a means of evaluating the interrelations of variables measured by the line technique.--Auth.

2-2537. Barrett, Paul H., ed. A TRANSCRIPTION OF DARWIN'S FIRST NOTEBOOK ON "TRANSMUTATION OF SPECIES": Harvard Univ., Mus. Comp. Zoology, Bull., v. 122, no. 6, p. 247-296, 4 illus., Apr. 1960, approx. 85 refs.

From July 1837 until July 1839, Darwin filled a number of notebooks on the subject of evolution; 6 of these are kept at the University Library, Cambridge, England. This is a transcription of the first of these reproduced as faithfully as possible. Punctuation has been added where necessary; bibliographic references have been traced and included in their completed form in appended notes. The notes embody Darwin's diverse observations and conjectures on the theory then being formulated. Many references are made to botany, zoology, paleontology, geology, and previously published works on these subjects.--M. Russell.

2-2538. Hotton, Nicholas, III. THE CHORDA TYMPANI AND MIDDLE EAR AS GUIDES TO ORIGIN AND DIVERGENCE OF REPTILES: Evolution, v. 14, no. 2, p. 194-211, illus., diag., June 1960, 28 refs.

The paper reviews the development of the bony parts of the middle ear in primitive tetrapods and discusses the homology of different bones and processes forming part of this organ in fossil and living Amphibia and Reptilia. The middle ear anatomy is described in several groups of labryinthodonts, primitive and modern Amphibia and Reptilia, including the position of the Chorda tympani, a branch of the facial nerve that passes through the middle ear cavity on its way to the lower jaw. Evolution of the middle ear took place under influence of modifications of jaw structure as well as through selection towards refinement of hearing. The position of the nerve studied has nothing to do with function of either the middle ear or the jaw mechanism and is therefore considered to be of value in determining patterns of phylogeny. Four main stages in evolution of the middle ear are distinguished, the first being that of the labyrinthodonts. The fourth stage is divided into 2 divergent parts, permitting separation of the reptiles into 2 lines; one line leads from captorhinomorphs to the diapsid reptiles and the birds, the other from the pelicosaurs to the therapsids and the mammals. --C. Voûte.

2-2539. Raw, Frank. OUTLINE OF A THEORY OF ORIGIN OF THE VERTEBRATE: Jour. Paleontology, v. 34, no. 3, p. 497-539, 6 illus., table, May 1960, 135 refs.

Vertebrates are derived from a very primitive Precambrian marine arthropod, the stage before compound eyes were evolved. Vertebrates arose from its free-swimming larval stage, and their organs evolved, through those of the protarthropod, from those of the annelid. The evolution and deployment of the lower fishes (s. l.) are sketched. The first vertebrates evolved mainly in fresh water within one or more river basins of perhaps a "North-Atlantic" continent, though before this their ancestors were marine.

Through feeding on what floated down the streams to them, and learning to maintain their position against the current, the ancestors of the fish improved their ability to swim; by the time they reached the upland lakes, they were expert swimmers and might well be called fish. Becoming independent of the bottom except for rest, they swam near the surface, subsisting largely on floating food. Stimulated by this and by the light also from above, their complex ectodermal nervous system (perhaps 3 pairs of cords) migrated toward the mid-dorsal line, where overfolding from each side originated the tubular nerve cord.

Concomitantly, on the ventral side, with the increasing speed of swimming, the protarthropod mode of feeding was replaced by the chordate mode. The forward transport of food towards the mouth along the food groove between the 2 rows of appendages slowed down; and the food groove acquired digestive functions. Ultimately, all food was received in front, passed back along the food groove, and was digested in it. The arthropod gut was thus superseded and was absorbed. The arthropodan appendages of each segment coalesced ventrally to form a new gut and a new ventral body wall. Appendage-parts thus became gill arches, whereas the gaps between them formed the so-called "gill-slits," except that an anterior and a posterior gap formed respectively the new mouth and the new anus.

Further efficiency in swimming was effected when turgid cells along the top of the food groove acted as an elastic rod, became completely ensheathed in connective tissue and formed the notochord. Further, since with more rapid swimming fewer gills were needed, the partings between the gill arches, from behind forwards, progressively closed, and the sections of body cavity within the gill arches became united to form the splanchnocoel. Thus arose a new gut and new ventral body-wall.

Many peculiarities find their explanation in this theory: the vertebrate eyes acquired their character by the neural overfolds above mentioned and are traceable, together with the 4-fold pineal eye of primitive vertebrates back to the polychaete; the jaws are derived from an anterior pair of the protarthropod appendages, the upper jaw from their proximal, the lower from their distal parts; the vertebrate limbs, originating as fins, arose, each from a group of protarthropod pleura, which are appendage parts, traceable back to the polychaete, and were still moved by muscles. Further, the pectoral and pelvic arches originated, each from a group of gill-arches, and hence from groups of appendages of the protarthropod.

The fish evolved before Cambrian time. But the course of its evolution can be determined, because its detailed effects are seen in the structures and tissues inherited by fossil and modern forms.--Auth.

2-2540. Sillman, Leonard R. THE ORIGIN OF THE VERTEBRATES: Jour. Paleontology, v. 34, no. 3, p. 540-544, May 1960, 22 refs.

The embryology of the vertebrates resembles that of the cephalopod much more than that of the echinoderm. The basic structuring of circulatory, respiratory, renal, and skeletal system in Nautilus shows marked similarities with those in the vertebrates. By contrast, echinoderms lack any distincitive basic adult vertebrate features. The transformation from a nautiloid to a vertebrate would violate no known evolutionary process, and would explain the enigmatic vertebrate pineal eye. It is proposed that the vertebrate originated from an orthoconic nautiloid cephalopod.--Auth.

2-2541. Easton, W.H. PERMIAN CORALS FROM NEVADA AND CALIFORNIA: Jour. Paleontology, v. 34, no. 3, p. 570-583, 17 illus., sec., May 1960, 13 refs.

Seven species of rugose corals are described from Permian (mostly Leonard series) strata in the Basin and Range province of Nevada and California. Caninia trojana, Lithostrotionella mokomokensis, Lithostrotionella dilatata, Diphyphyllum connorsensis, Thysanophyllum princeps, Lonsdaleia illipahensis, and Lonsdaleia cordillerensis are named. The corals occur in thick successions of commonly cyclical alternations of limestone and sandstone near the eastern margin of the Cordilleran geosyncline. Local distribution and biostromal development can be used in subdividing and mapping the Permian strata of E.-central Nevada.--Auth.

2-2542. Hampton, John S. A STATISTICAL ANALYSIS OF RHABDOTITES DORSETENSIS HODSON, HARRIS AND LAWSON, 1956: Micropaleontology, v. 6, no. 3, p. 307-314, pl., 4 tables, July 1960, 13 refs.

Employing criteria proposed as an objective basis for the "speciation" of fossil holothurian sclerite morphogroups, the differentiating continuous and discontinuous variates of 1,169 topotype specimens of Rhabdotites, from the Oxfordian (Upper Jurassic) strata of Redcliff, near Weymouth, Dorset, England, are subjected to univariate statistical analysis. The discontinuous variate of pustule number is shown to be a nondifferentiating "specific" character, and the "species" (qua parataxa) Rhabdotites dorsetensis Hodson, Harris and Lawson, R. divergens Hodson, Harris and Lawson, R. bifidus Hodson, Harris and Lawson, R. tridens Hodson, Harris and Lawson, and R. irregularis Hodson, Harris and Lawson, are placed in the single "species" (qua parataxon) R. dorsetensis Hodson, Harris and Lawson, which is revised.--Auth.

2-2543. Boucot, Arthur J. A NEW LOWER DEVONIAN STROPHEODONTID BRACHIOPOD: Jour. Paleontology, v. 34, no. 3, p. 483-485, pl., May 1960, 7 refs.

Lower Devonian brachiopods from Nova Scotia show affinities with the Rhenish faunal province. Rhenostrophia, a new subgenus of Stropheodonta is described.--Auth.

2-2544. Jones, David L. PELECYPODS OF THE GENUS PTEROTRIGONIA FROM THE WEST COAST OF NORTH AMERICA: Jour. Paleontology, v. 34, no. 3, p. 433-439, 2 pls., map, chart, May 1960, 18 refs.

Three species of Pterotrigonia from Cretaceous rocks of the W. coast of North America, P. evansana (Meek), P. klamathonia (Anderson), and P. oregana (Packard), are redescribed and figured. Trigonia inezana Packard and T. churchi Anderson are considered to be synonyms of P. evansana. T. deschutesensis Packard is considered to be a synonym of P. oregana.

P. evansana ranges from the Coniacian to the Campanian; P. klamathonia ranges throughout the Turonian, and P. oregana ranges from lower to middle Albian to about upper Cenomanian.--Auth.

2-2545. Packard, Earl L. HYPOTYPES OF PHYLLOCERAS ONOENSE STANTON: Jour. Paleontology, v. 34, no. 3, p. 421-428, 3 pls., 2 illus., table, May 1960, 23 refs.

A lectotype of Phylloceras onoense Stanton, the type species of the genus Hypophylloceras, is here selected from the 2 original specimens of Ammonites ramosus Gabb (not Meek) on which Stanton (in part) originally based his species. Gabb's 2 specimens are not conspecific, and a possible new species of Hypophylloceras is suggested for the second specimen.--Auth.

2-2546. Whittington, Harry B. UNIQUE FOSSILS FROM VIRGINIA: Virginia Minerals, v. 6, no. 3, 7 p., 5 illus., July 1960.

A popular, simplified version of GeoScience Abstracts 2-611.

2-2547. Whittington, Harry B. CORDANIA AND OTHER TRILOBITES FROM THE LOWER AND MIDDLE DEVONIAN: Jour. Paleontology, v. 34, no. 3, p. 405-420, 4 pls., illus., May 1960, 32 refs.

The type and 5 additional species of Cordania, from the Lower Devonian of Quebec, Maine, New York, Tennessee, and Oklahoma, are described. Facial sutures are present, the anterior branches widely divergent; 9 thoracic segments. Mystrocephala n. gen. (type species C. pulchra Cooper and Cloud) includes Lower and Middle Devonian species differing from Cordania in that cheek and preglabellar field are concave distally and lack the convex border; pygidium has prominent posterior pleural bands extending to margin. The 2 genera are placed in Brachymetopidae, and a new diagnosis of that family given. Two species from Maine which occur with Cordania macrobius (Billings) are described: Bojoscutellum? pompilius (Billings), a scutelluid of uncertain generic affinities, and Astycoryphe? junius (Billings), a proetid with a weakly developed tropidium and Astycoryphe-like pygidium.--Auth.

2-2548. Palmer, Allison R. MIOCENE COPEPODS FROM THE MOJAVE DESERT, CALIFORNIA: Jour. Paleontology, v. 34, no. 3, p. 447-452, pl., illus., May 1960, 8 refs.

Fossil copepods are described for the first time. An undetermined cyclopoid species and a harpacticoid assignable to the recent genus Cletocamptus are evidence that copepods of modern aspect existed by Miocene time.--Auth.

2-2549. Pierce, W. Dwight. FOSSIL ARTHROPODS OF CALIFORNIA. NO. 23. SILICIFIED IN-

SECTS IN MIOCENE NODULES FROM THE CALICO MOUNTAINS: Southern California Acad. Sci., Bull., v. 59, pt. 1, p. 40-49, 10 illus., table, Jan.-Apr. 1960, 3 refs.

In no. 22 of this series (GeoScience Abstracts 2-1438), the writer presented a general report on studies of fossils found in calcareous petroliferous nodules of Miocene age in Southern California. Recovery of the fossils has continued, with particular concentration on the nodules from the Calico Mountains. The vast amount of material accumulating, necessitates breaking down the results in short papers as rapidly as accurate reports can be prepared. The present paper includes some of the rarer finds in several orders: Collembola, Ephemerida, Plecoptera, Corrodentia, and Coleoptera.--From auth.

2-2550. Snyder, Thomas E. FOSSIL TERMITES FROM TERTIARY AMBER OF CHIAPAS, MÉXICO (ISOPTERA): Jour. Paleontology, v. 34, no. 3, p. 493-494, pl., May 1960.

A new fossil termite, Heterotermes primaevus, and a recent species, Kalotermes nigritus are recorded from amber of late Oligocene or early Miocene age from near Simojovel, Chiapas, Mexico.--Auth.

2-2551. Muesebeck, C. F. W. A FOSSIL BRACONID WASP OF THE GENUS ECPHYLUS (HYMENOPTERA): Jour. Paleontology, v. 34, no. 3, p. 495-496, illus., May 1960.

A braconid wasp, Ecphylus oculatus n. sp., the first known fossil of this genus, is described from amber of late Oligocene or early Miocene age from near Simojovel, Chiapas, Mexico.--Auth.

2-2552. Denison, Robert H. FISHES OF THE DEVONIAN HOLLAND QUARRY SHALE OF OHIO: Chicago, Nat. History Mus., Fieldiana: Geology, v. 11, no. 10, p. 555-613, 74 illus., 14 diags., June 22, 1960, 23 refs.

The Holland Quarry shale, a Lower Devonian formation known from a single small exposure in Lucas County, northwestern Ohio, has yielded plants, eurypterids, and vertebrates. The vertebrates are described in this paper. The Cyathaspidae are represented by Allocryptaspis laticostatus, n. sp. The most abundant form belongs to the Pteraspidae and has been named Pteraspis carmani, n. sp. Its generic reference is arbitrary, and it is closely related and may be ancestral to Protaspis. Some aspects of its growth and individual variation have been considered. The arthrodire, a relatively rare element in the fauna, is Aethaspis ohioensis, n. sp., a small and primitive member of the genus. Spines of acanthodians have been referred to Onchus cf. peracutus Bryant.

The vertebrates indicate that the Holland Quarry shale should be correlated with the upper Dittonian or equivalent lower Siegenian of the European Lower Devonian. This is probably of the same age as the Deerpark stage of the North American standard section. The vertebrate assemblage is similar to those of the Beartooth Butte formation of Wyoming and the Water Canyon formation of Utah. The author believes that the Holland Quarry shale was deposited in salt or brackish water, possibly in a channel or estuary opening into the transgressing sea to the N.--Auth. summ.

2-2553. Olson, Everett C. A TRILOPHOSAURID REPTILE FROM THE KOOTENAI FORMATION (LOWER CRETACEOUS): Jour. Paleontology, v. 34, no. 3, p. 551-555, 3 illus., table, May 1960, 3 refs.

A new genus and species of reptile of the family Trilophosauridae is described. The specimen upon which the description is based was found in the Kootenai formation, Lower Cretaceous, of Montana. Previously the family has been known only from the Upper Triassic.--Auth.

2-2554. Rohrer, W. L., and R. L. Konizeski. ON THE OCCURRENCE OF EDMONTOSAURUS IN THE HELL CREEK FORMATION OF MONTANA: Jour. Paleontology, v. 34, no. 3, p. 464-466, pl., map, sec., table, May 1960, 8 refs.

A specimen of Edmontosaurus from the Hell Creek formation of Montana substantiates the correlation of the Upper Cretaceous Hell Creek formation with the upper Edmonton member of Alberta. It may be a new species.--Auth.

2-2555. Wetmore, Alexander. PLEISTOCENE BIRDS IN BERMUDA: Smithsonian Inst., Smithsonian Misc. Colln., v. 140, no. 2, 11 p., 10 illus. on 3 pls., July 1960.

Cave deposits of calcareous tufa in the H. Bernard Wilkinson quarry, S. and W. of Coney Island, Hamilton Parish, Bermuda, have yielded excellently preserved Pleistocene specimens of the Bermuda petrel, the cahow, and 2 previously undescribed birds - a duck, Anas pachyscelus, sp. nov., and a crane, Baeopteryx latipes, gen. and sp. nov.--M. Russell.

2-2556. Slaughter, Bob H. A NEW SPECIES OF SMILODON FROM A LATE PLEISTOCENE ALLUVIAL TERRACE DEPOSIT OF THE TRINITY RIVER: Jour. Paleontology, v. 34, no. 3, p. 486-492, pl., illus., table, May 1960, 17 refs.

A new species of Smilodon, S. trinitiensis, is described from the Pleistocene deposits forming an alluvial terrace above the Trinity River at Dallas, Texas.--Auth.

2-2557. Olsen, Stanley J. THE FOSSIL CARNIVORE AMPHICYON LONGIRAMUS FROM THE THOMAS FARM MIOCENE. PART II - POSTCRANIAL SKELETON: Harvard Univ., Mus. Comp. Zoology, Bull., v. 123, no. 1, 44 p., illus. on pl., 21 figs., July 1960, 23 refs.

A fairly comprehensive study of a comparatively rare animal from the productive lower Miocene locality in Gilchrist County, Florida. Amphicyon is compared to the bear, puma, and dog, since it shows a mixture of the characteristics of these 3. These similarities do not necessarily indicate close taxonomic relationships; they are probably habitus characters. The postcranial skeleton of Amphicyon is proportionately heavier than in any member of the Canidae and the limbs and feet are close to those of the true ursids. Nothing noted in the morphological features of the skeleton link Amphicyon with the felids. Drawing the canid-ursid line on the evidence of the dentition and skeleton, the Ursidae become distinct above the Oligocene with Daphoenodon and Amphicyon forming an offshoot from the main ursid line during the Miocene and becoming extinct before the middle Pliocene. The author believes that the affinities of Amphicyon and Daphoenodon are with the

bears, and proposes that the subfamily Amphicyoninae, usually included under the Canidae, be transferred to the Ursidae.--F.C. Whitmore, Jr.

2-2558. Green, Morton, and Harold Martin. BISON LATIFRONS IN SOUTH DAKOTA: Jour. Paleontology, v. 34, no. 3, p. 548-550, 2 illus., table, May 1960, 8 refs.

A nearly complete skull with horn cores of Bison latifrons (Harlan) is average in size for the species and marks the most northern find to date. The stratigraphic range of the species is either medial to late Pleistocene or late Pleistocene only.--Auth.

2-2559. Green, Morton. A TERTIARY CYNOMYS FROM SOUTH DAKOTA: Jour. Paleontology, v. 34, no. 3, p. 545-547, 6 illus., table, May 1960, 6 refs.

A new species of Tertiary prairie dog, Cynomys spispiza, is represented by a partial lower jaw that was found on the surface of a Valentine sand. The species is compared with Cynomys ludovicianus and C. leucurus to which the fossil is related. The temporal range of the genus is extended to the early Pliocene or late Miocene. No evidence is available to determine the ancestry of Cynomys.--Auth.

2-2560. Olsen, Stanley J. FOSSIL MAMMALS OF FLORIDA: Florida Geol. Survey, Spec. Pub. no. 6, 75 p., 15 illus., 5 maps, sec., 6 charts, 1959.

A popular account of Florida's Tertiary mammals with locality references and general information relating to vertebrate fossils found within the state.--Auth.

2-2561. Downie, Charles. DEUNFFIA AND DOMASIA, NEW GENERA OF HYSTRICHOSPHERES: Micropaleontology, v. 6, no. 2, p. 197-202, 9 illus. on pl., 5 diags., table, Apr. 1960, 8 refs.

Seven new species of microfossils from the Buildwas shales (Wenlockian) of England are described. They are grouped with the hystrichospheres and assigned to 2 new genera, Deunffia and Domasia. Veryhachium monacanthum Deunff is transferred to Deunffia.--Auth.

2-2562. Schell, William W., and David L. Clark. LOWER TRIASSIC FORAMINIFERA FROM NEVADA: Micropaleontology, v. 6, no. 3, p. 291-295, pl., sec., July 1960, 6 refs.

Acid residues from limestone obtained from a single locality in eastern Nevada have yielded 5 lagenid species of Triassic foraminifera. The specimens are silicified and are present in over 600 ft.of section. The fauna is associated with Lower Triassic conodonts and occurs about 1,000 ft. above the Lower Triassic (Scythic) ammonoid guide, Meekoceras.--Auth.

2-2563. Cifelli, Richard. VARIATION OF ENGLISH BATHONIAN LAGENIDAE AND ITS PHYLOGENETIC SIGNIFICANCE: Jour. Paleontology, v. 34, no. 3, p. 556-569, 6 illus., May 1960, 27 refs.

Study of the English Bathonian emphasizes the need for recognition of variable species in the classification of the Jurassic Lagenidae. There is evidence that generally accepted generic as well as species characters vary considerably within a single species of this difficult group. It is suggested that "key" characters used to define genera should be treated cautiously and evaluated in light of other test features. Additional important clues in the taxonomy of this group are factors of distribution and the occurrence of transitional forms between distinct types in a single assemblage.

Recognition of variable species among the Jurassic Lagenidae is compatible with genetic and evolutionary theory. Moreover, the occurrence of variants is believed to provide important clues to the phylogeny of the group. The occurrence of identical structural types in distinct lineages suggests that many of the described genera of Lagenidae are polyphyletic.--Auth.

2-2564. Seibold, Eugen, and Ilse Seibold. FORAMINIFERA IN SPONGE BIOHERMS AND BEDDED LIMESTONES OF THE MALM, SOUTH GERMANY: Micropaleontology, v. 6, no. 3, p. 301-306, 5 illus., chart, 4 secs., 2 diags., 3 graphs, July 1960, 7 refs.

Only bedded limestones and marls and bioherms of sponges are to be found in the deposits of the northern border of Oxfordian Tethys. Among the 132 species of foraminifera occurring here, 31 are characteristic of the bedded facies, and 14 of the sponge environment. These are restricted to the direct neighborhood of the sponge bioherms. Moreover, the carbonate content has some influence on the microfauna. These facts indicate the scarcity of bottom currents.--Auth.

2-2565. Hofker, Jan. THE TAXONOMIC STATUS OF PRAEGLOBOTRUNCANA, PLANOMALINA, GLOBIGERINELLA, AND BIGLOBIGERINELLA: Micropaleontology, v. 6, no. 3, p. 315-322, 2 pls., chart, July 1960, 9 refs.

Four genera, Praeglobotruncana, Planomalina, Globigerinella, and Biglobigerinella, are shown to be different developmental stages of single biological units. Three of these units can be followed in their development passing through these artificial "genera," the stages having been named as different artificial "species." One unit began and ended in the Albian; a second one began in the Albian and ended in the upper Maestrichtian; and a third one began in the Danian and has not yet fully ended in the Recent. Such artificial genera have no taxonomic value, and appear to be totally invalid.--Auth.

2-2566. Barr, K.W. THE OCCURRENCE OF CHOFFATELLA DECIPIENS IN TRINIDAD: Micropaleontology, v. 6, no. 3, p. 323, July 1960, 5 refs.

The presence of Choffatella decipiens in the "Toco beds" of Trinidad is discussed, and the sole occurrence of the species in that area is found to be within the Tompire formation.--Auth.

2-2567. Douglass, Raymond C. REVISION OF THE FAMILY ORBITOLINIDAE: Micropaleontology, v. 6, no. 3, p. 249-270, 6 pls., illus., 2 maps, table, July 1960, 53 refs.

The foraminiferal family Orbitolinidae is represented in rocks of early Cretaceous through Eocene age. The genera Coskinolinoides, Iraqia, Simplorbitolina, Orbitolina, and Dictyoconus are included in the family because of the similarity of their wall structure and general test development. Genera previously assigned to this family which do not have the characteristic wall structure are removed from

ne family. Each of the genera assigned to the Orbitolinidae is diagnosed, on the basis of topotypes f the type species of each of the genera.--Auth.

-2568. Cole, W. Storrs. VARIABILITY IN EMBRYONIC CHAMBERS OF LEPIDOCYCLINA: Micropaleontology, v. 6, no. 2, p. 133-144, 4 pls., table, pr. 1960, 27 refs.

The variability in shape of the embryonic chambers of Lepidocyclina (Pliolepidina) pustulosa H. Douillé from the American upper Eocene and L. (Eulepidina) radiata (Martin) from the Indo-Pacific Miocene is discussed and illustrated. Each of these pecies contains specimens which have a single set f embryonic chambers, others which have 2 sets of hese chambers and still others possess multiple embryonic chambers. The probable cause of this delopment in the 2 species is given. Synonyms of he species are discussed. A tentative revision of he subgenera of Lepidocyclina is given.--Auth.

-2569. Said, Rushdi. PLANKTONIC FORAMINFERA FROM THE THEBES FORMATION, LUXOR, EGYPT: Micropaleontology, v. 6, no. 3, p. 277-86, pl., sec., 2 tables, July 1960, 30 refs.

Formational names of rock units of the lower Tertiary Libya group in Egypt are introduced. The planktonic foraminifera of the Thebes formation, Libya roup from the type locality at Luxor, Egypt are described and illustrated. The planktonic foraminifera ound in the underlying Esna shale are described. The Esna shale in Luxor, having a fauna of sharply keeled Globorotalia species, is considered to be of pper Paleocene (Landenian) age. The overlying Thebes formation contains a planktonic fauna of moother and more compressed types: Globorotalia hebaica, n. sp., G. imitata Subbotina and G. planoconica Subbotina. The Thebes formation is believed o represent the open sea facies of the Egyptian lower Eocene (Ypresian).--Auth.

-2570. Todd, Ruth, and Doris Low. SMALLER FORAMINIFERA FROM ENIWETOK DRILL HOLES: J.S. Geol. Survey, Prof. Paper 260-X, p. 799-861, 0 pls., map, chart, 2 secs., 7 tables (4 in pocket), 960, 62 refs.

Smaller Foraminifera were studied as loose specimens from 2 deep holes, about 22 mi. apart, drilled o the basement rock underlying Eniwetok Atoll: hole -1 about 4,200 ft. deep on the southeastern part of he atoll and hole F-1 about 4,600 ft. deep on the orthwestern part of the atoll near where it adjoins guyot.

In both holes, Miocene and upper Eocene sediments were recognized and in hole E-1 a 590-ft. sequence of beds is tentatively placed in the lower Oligocene. Tentative correlation is made between 350-ft. sequence of upper Eocene faunas from the ppermost occurrence of Eocene beds in hole E-1 to he lowermost rocks in hole F-1. A thick sequence f Eocene Globigerina limestone represents the upermost occurrence of Eocene beds in hole F-1 and ignifies open-sea deposition. Globigerinids and eepwater forms in association with other species ccur in the lower part of the section in hole F-1 nd signify moderately deepwater deposition, probbly on an outer slope of the atoll. No evidence on he deposition of the sediments found in the middle art of this hole can be based on smaller Foraminifera. The Miocene sediments in the upper part of the hole indicate shallow but possibly outer slope deposition.

Throughout the part of hole E-1 from which cuttings were obtained, the smaller Foraminifera indicate shallow-water deposition, with the possibility of 2 disconformities or diastems in the lower part. No smaller Foraminifera are available from the lowest 1,100 ft. of this hole.

Comparison with the deep holes drilled on Bikini shows close conformity, particularly with hole E-1, in which deposition is of the same type as in the Bikini holes. Correlation of several tops of occurrences, however, shows that levels are slightly shallower at Eniwetok, as much as 250 ft.

Paleontologic affinities of the species seem to be about equally divided between the eastern and western hemispheres. In the Eocene, notable ties are recognizable to the southeastern United States and the West Indies as well as to central Europe and the Near East. A few correlations can be made with the described East Indian faunas of smaller Foraminifera. In the lower Oligocene the major ties are to the southeastern United States. In the Miocene, paleontologic affinities are noted mainly with Australia, New Zealand, Fiji, and other Pacific islands, and less frequently with the United States, West Indies, and Europe.

Altogether, 265 species, 4 subspecies, and 3 varieties, classified in 118 genera, are recognized in the material from the drill holes. Of these, 7 species are described as new, and 29 remain indeterminate because of lack of adequate material for identification or description.--Auth.

2-2571. Cheetham, Alan H. RIMOSOCELLA, NEW GENUS OF CHEILOSTOME BRYOZOA: Micropaleontology, v. 6, no. 3, p. 287-289, 5 illus., July 1960, 6 refs.

A new genus, Rimosocella, is proposed for cheilostome bryozoa described by Canu and Bassler (1920) as Quadricellaria? laciniosa. Study of topotypes from the Castle Hayne marl (Eocene) of North Carolina and additional material from the McBean formation (Eocene) of Georgia has disclosed the necessity for complete redescription and illustration of the species.--Auth.

2-2572. Berdan, Jean M. REVISION OF THE OSTRACODE FAMILY BEECHERELLIDAE AND REDESCRIPTION OF ULRICH'S TYPES OF BEECHERELLA: Jour. Paleontology, v. 34, no. 3, p. 467-478, pl., May 1960, 26 refs.

Restudy of the types of the species assigned to Beecherella by Ulrich in 1891 shows that the family Beecherellidae, consisting of the genera Beecherella and Acanthoscapha, belongs in the Podocopa. Acanthoscapha Ulrich & Bassler 1923 is a senior synonym of Alanella Bouček 1936. Most of the species originally assigned to Beecherella belong in various other genera and families.--Auth.

2-2573. Sohn, I.G., and Jean M. Berdan. THE OSTRACODE FAMILY BEROUNELLIDAE, NEW: Jour. Paleontology, v. 34, no. 3, p. 479-482, pl., May 1960, 10 refs.

The family Berounellidae is erected for the Paleozoic genera Berounella Bouček, 1936, and Kirkbyellina Kummerow, 1939. Specimens of undescribed species of Berounella are illustrated for the first time in North America.--Auth.

2-2574. Neale, John W. MARINE LOWER CRETACEOUS OSTRACODA FROM YORKSHIRE, ENGLAND: Micropaleontology, v. 6, no. 2, p. 203-224, 4 pls., map, sec., 2 charts, table, Apr. 1960, 37 refs.

Twenty-seven species of marine Ostracoda from British Lower Cretaceous rocks are figured and described. The new subgenus Acrocythere is defined, together with 3 new species, 2 new subspecies, and 1 new name to replace a homonym. Eight species are left under nomenclatura aperta. Comparisons are made with Hauterivian and Barremian ostracode faunas of northern Europe.--Auth.

2-2575. Van Den Bold, W.A. EOCENE AND OLIGOCENE OSTRACODA OF TRINIDAD: Micropaleontology, v. 6, no. 2, p. 145-196, 8 pls., 2 maps, sec., diag., 4 charts, Apr. 1960, 89 refs.

More than 100 species of ostracodes are described or listed from the Eocene and Oligocene of Trinidad. One genus and 34 species are new, 46 species have been described previously from the Caribbean and the Gulf Coast. It is shown that the genus Krithe can be used for biostratigraphic zonation.--Auth.

2-2576. Schopf, James M. DOUBLE COVER-GLASS SLIDES FOR PLANT MICROFOSSILS: Micropaleontology, v. 6, no. 2, p. 237-240, 6 diags., Apr. 1960, 8 refs.

A quick and simple method of preparing permanent slides of plant microfossils on cover-glasses for immediate examination.--Auth.

2-2577. Tschudy, Robert H. "VIBRAFLUTE": Micropaleontology, v. 6, no. 3, p. 325-326, diag., July 1960.

Construction and operational details of a machine for separating fine organic and inorganic debris from palynomorph preparations are described.--Auth.

2-2578. Arms, Bernard C. A SILICA DEPRESSANT METHOD FOR CONCENTRATING FOSSIL POLLEN AND SPORES: Micropaleontology, v. 6, no. 3, p. 327-328, diag., July 1960, 3 refs.

A simple, rapid, and inexpensive method for concentrating pollen and spores and for cleaning other microfossils is described.--Auth.

2-2579. Staplin, Frank L., Stanley A.J. Pocock, J. Jansonius, and E.M. Oliphant. PALYNOLOGICAL TECHNIQUES FOR SEDIMENTS: Micropaleontology, v. 6, no. 3, p. 329-331, July 1960, 9 refs.

A comprehensive set of palynological techniques usable for extracting representative fossil assemblages from different lithologies is presented.--Auth.

2-2580. Gray, Jane. FOSSIL CHLOROPHYCEAN ALGAE FROM THE MIOCENE OF OREGON: Jour. Paleontology, v. 34, no. 3, p. 453-463, pl., illus., map, May 1960, 41 refs.

Two genera of fossil fresh-water algae, Pediastrum and Botryococcus, and several specimens tentatively referred to Tetraedron, are recorded from lacustrine-fluviatile sediments of the late middle Miocene Mascall formation from the John Day basin, Oregon, and from strata equivalent in age or somewhat younger from the Blue Mountains to the NE., and the Stinking Water basin to the S. The fossil Pediastrum and Botryococcus are compared with the living species, P. boryanum, P. duplex, and B. braunii on the basis of gross morphology. Specimens referred to Pediastrum are the first record of this genus in North American Tertiary sediments.--Auth.

2-2581. Ross, June R.P. Phillips. TYPE SPECIES OF PTILODICTYA - PTILODICTYA LANCEOLATA (GOLDFUSS): Jour. Paleontology, v. 34, no. 3, p. 440-446, 2 pls., diag., table, May 1960, 6 refs.

This redescription of the type species of the cryptostome genus Ptilodictya, Ptilodictya lanceolata. (Goldfuss), based on original material and additional specimens discusses zoarial structures and their development.--Auth.

2-2582. Brown, Roland W. CORKWOOD IN THE EOCENE FLORA OF THE SOUTHEASTERN UNITED STATES: Jour. Paleontology, v. 34, no. 3, p. 429-432, pl., May 1960, 14 refs.

Eight species in 7 genera, none heretofore identified as Leitneria (corkwood), are synonymized as Leitneria eocenica (Berry) Brown, n. comb., the first recognition of that genus in the Eocene flora of the southeastern United States. This example points the need for a thorough restudy of the entire flora.--Auth

2-2583. Scott, Richard A. POLLEN OF EPHEDRA FROM THE CHINLE FORMATION (UPPER TRIASSIC) AND THE GENUS EQUISETOSPORITES: Micropaleontology, v. 6, no. 3, p. 271-276, pl., 2 diags. July 1960, 13 refs.

Recently discovered pollen grains with asymmetrically ridged ektexines from the Chinle formation (Upper Triassic) represent the extant genus Ephedra. The holotype specimen of Equisetosporites chinleana Daugherty is also a conspecific Ephedra pollen grain and the species is transferred to form the new combination Ephedra chinleana (Daugherty) R.A. Scott. Since this species was its genotype, the genus Equisetosporites Daugherty should be abandoned.--Auth.

2-2584. Groot, Johan J., and John S. Penny. PLANT MICROFOSSILS AND AGE OF NONMARINE CRETACEOUS SEDIMENTS OF MARYLAND AND DELAWARE: Micropaleontology, v. 6, no. 2, p. 225-236, 2 pls., map, 4 tables, Apr. 1960, 23 refs.

A study of spores and pollen in nonmarine sediments of Cretaceous age from Maryland and Delawa indicates that these deposits range from Lower Cretaceous to lowermost Upper Cretaceous. Twenty-two species of spores and pollen are described, 11 of which are new.--Auth.

2-2585. Brindle, John E. MISSISSIPPIAN MEGAFAUNAS IN SOUTHEASTERN SASKATCHEWAN: Saskatchewan, Dept. Mineral Resources, Rept. no. 45, 107 p., 29 pls., map, sec., 2 charts (1 in pocket), 1960, 78 refs.

The fossils studied in this report (over 160 species, principally corals and brachiopods) were obtained from well cores taken in the Mississippian Bakken formation (shales and sandstones) and Madison group (carbonates and evaporites) in southeaste Saskatchewan, Canada. The faunal assemblage re-

overed is presented from, and an age ascribed to, ach stratigraphic unit in this succession. The as- emblages reveal a mixture of types previously re- orded from the type area of the Mississippian, with thers recorded from western North America. Cer- ain rugose corals are previously recorded (in liter- ture) only from the U.S.S.R. The Bakken formation s of Kinderhookian age. The Madison group ranges n age from Kinderhookian to Meramecian. The Mis- sissippian faunal zones proposed by Harker and Ra- sch in Alberta are tentatively extended into Sas- atchewan, and correlations are proposed with the Mississippian succession in the Alberta plains and oothills, and that in the Alberta Rocky Mountains. The fossils are illustrated by photographs wherever ossible.--Auth.

2-2586. Hibbard, Claude W., and Dwight W. Taylor. TWO LATE PLEISTOCENE FAUNAS FROM SOUTH- WESTERN KANSAS: Michigan Univ., Mus. Paleon- tology, Contr., v. 16, no. 1, 223 p., 16 pls., 9 illus., 7 maps, 2 charts, 9 tables, July 1960, 250 refs.

An unusually full history of Pliocene and Pleisto- cene times is to be found recorded in southwestern Kansas and northwestern Oklahoma. The stratigraph- ic and paleontologic work by Claude W. Hibbard and field parties, from the University of Kansas (1936- 1946) and University of Michigan (1947-1958), has revealed there the most nearly complete latest Ceno- zoic faunal succession that is known for a small area anywhere in the world. The 2 late Pleistocene faunas described in this paper are from long-recognized localities, but they have not previously been studied in detail. These assemblages, the Butler Spring and Cragin Quarry local faunas, add considerably to our knowledge of Illinoian and early Sangamon history in the southern Great Plains. No precise equivalent to the early Sangamon Cragin Quarry local fauna has been found elsewhere in the Great Plains, but the Berends local fauna of northwestern Oklahoma is probably a correlative of the Illinoian Butler Spring local fauna.--Auth. introd.

6. GEOPHYSICS

See also: Geologic Maps 2-2455 through 2-2462, 2-2464 through 2-2477; Structural Geology 2-2505, 2-2514; Geochemistry 2-2614; Mineral Deposits 2-2707.

2-2587. Fischer, Irene. AN ASTROGEODETIC WORLD DATUM FROM GEOIDAL HEIGHTS BASED ON THE FLATTENING f = 1/298.3: Jour. Geophys. Research, v. 65, no. 7, p. 2067-2076, 7 maps, 2 diags., profile, July 1960, 6 refs.

The value 1/298.3 for the flattening of the earth is accepted in the determination of a world ellipsoid. The astrogeodetic geoid is extended into the Carib- bean, India, and Burma, and modified in the Soviet Union and the Far East. The resulting world ellips- oid is very small, with an equatorial radius of about 6,378,160 m. The agreement between astrogeodetic and gravimetric geoid profiles is greatly improved by the small ellipsoid.--Auth.

2-2588. Munk, Walter H., and Gordon J. F. Mac- Donald. CONTINENTALITY AND THE GRAVITA- TIONAL FIELD OF THE EARTH: Jour. Geophys. Research, v. 65, no. 7, p. 2169-2172, table, July 1960, 12 refs.

Satellite observations provide some information about zonal harmonics J_2, J_3, ... J_6 of the gravita- tional field. For a hydrostatic earth (all surfaces of equal density are level), odd harmonics vanish and even harmonics can be computed from precession and geophysical data. The authors have compared the nonhydrostatic (observed minus hydrostatic) har- monics with those calculated for the known distribu- tion of continents and some reasonable assumptions about density in the crust. The two sets of values do not agree, and this raises the possibility that density variations in the mantle, perhaps unrelated to the distribution of continents, are the important factor in determining the gravitational coefficients of low order.--Auth.

2-2589. Baldwin, Harry L., Jr., and David P. Hill. GRAVITY SURVEY IN PART OF THE SNAKE RIVER PLAIN, IDAHO - A PRELIMINARY REPORT: U.S. Geol. Survey, Repts., Open-File Ser., no. 511, 21 p., map (in pocket, scale 1:125,000), profile, 3 graphs, table, 1960, 8 refs.

During the early summer of 1959, a total of 1,187 gravity stations were occupied on the western part of the Snake River plain in Idaho. An area of 2,000 sq. mi. extending from Glenns Ferry, Idaho, to Cald- well, Idaho, was covered with a station density of 1 station per 2 sq. mi. An additional 1,200 sq. mi. of surrounding area, mainly from Caldwell, Idaho, to the Oregon-Idaho state line, was covered with a den- sity of 1 station per 7 sq. mi. The mean reproduci- bility of the observed gravities of these stations was 0.05 mgal., with a maximum discrepancy of 0.2 mgal. Gravity data were reduced to simple Bouguer values using a combined free-air and Bouguer cor- rection of 0.06 mgal. per ft.

The only anomalies found with closure in excess of 10 mgal. are 2 elongated highs, orientated NW.- SE., with the northwestern high offset to the NE. by 10 mi. The smaller of these highs extends from Meridian, Idaho, to Nyssa, Oregon, and the larger extends from Swan Falls, Idaho, to Glenns Ferry, Idaho. The maximum value recorded is a simple Bouguer value of -66.5 mgal. with respect to the International Ellipsoid. Gradients on the sides of these highs are largest on the NE. sides, reaching 6 mgal. per mi. in places. Graticule interpretations of a profile across the southeastern high using a density contrast of 0.3 gm.per $cm.^3$ indicate an ac- cumulation of lava reaching a thickness of at least 28,000 ft.--Auth.

2-2590. Hurwitz, Louis, and James H. Nelson. PROTON VECTOR MAGNETOMETER: Jour. Geo- phys. Research, v. 65, no. 6, p. 1759-1765, 3 illus., 2 tables, June 1960, 8 refs.

Z and H, as well as F, have been measured at the Fredericksburg Magnetic Observatory with a proton vector magnetometer, combining a proton-precession intensity magnetometer and a Helmholtz coil system mounted on a horizontal circle.

Formulas for the effect of various instrumental adjustments are given without proof; the only critical adjustment is the level of the horizontal circle (mag- netometer base). The internal consistency of the ob- served values Z_P, F_P, and H_P is indicated by the smallness of computed values $H_P - (F_P^2 - Z_P^2)^{1/2}$; these values are less than 3 γ in magnitude and have

a mean of 0.4 γ. Preliminary results of comparisons with the observatory sine galvanometer and earth inductor are:

PVM – SG (measurements of H) = 2.7 γ
PVM – EI (measurements of dip) = 1'

The source of the H difference is now being investigated.--Auth.

2-2591. Cox, Allan, and Richard R. Doell. REVIEW OF PALEOMAGNETISM: Geol. Soc. America, Bull., v. 71, no. 6, p. 645-768, 35 figs. incl. secs., diags., 2 tables, June 1960, 178 refs.; abs. in English, French, German, and Russian.

This review is an attempt to bring together and discuss relevant information concerning the magnetization of rocks, especially that having paleomagnetic significance. All paleomagnetic measurements available to the authors are here compiled and evaluated, with a key to the summary table and illustrations in English and Russian. The principles upon which the evaluation of paleomagnetic measurements is based are summarized, with special emphasis on statistical methods and on the evidence and tests for magnetic stability and paleomagnetic applicability.

Evaluation of the data summarized leads to the following general conclusions: 1) The earth's average magnetic field, throughout Oligocene to Recent time, has very closely approximated that due to a dipole at the center of the earth oriented parallel to the present axis of rotation. 2) Paleomagnetic results for the Mesozoic and early Tertiary might be explained more plausibly by a relatively rapidly changing magnetic field, with or without wandering of the rotational pole, than by large-scale continental drift. 3) The Carboniferous and especially the Permian magnetic fields were relatively very "steady" and were vastly different from the present configuration of the field. 4) The Precambrian magnetic field was different from the present field configuration and, considering the time spanned, was remarkably consistent for all continents.--Auth.

2-2592. Collinson, D.W., and S.K. Runcorn. POLAR WANDERING AND CONTINENTAL DRIFT: EVIDENCE FROM PALEOMAGNETIC OBSERVATIONS IN THE UNITED STATES: Geol. Soc. America, Bull., v. 71, no. 7, p. 915-958, map, 26 diags., 4 tables, July 1960, 34 refs.

Further studies of the paleomagnetic directions of red sandstones and siltstones of various geological ages in the United States are described. Usually the directions of magnetization of samples from a formation at one site are grouped symmetrically about a mean direction. From such a mean direction the position of the pole for that geological age can be calculated. There are, however, magnetically unstable formations in which the directions of magnetization are distributed approximately in the plane containing the present dipole field at the site and the original direction of the magnetic field. This planar distribution is the result of a superposition of a secondary magnetization on the original one. The former is thought to be a viscous or chemical magnetization acquired in the last 1,000-1,000,000 years.

Pole positions calculated from mean directions at different sites are consistent for the same formation and for different formations of the same geological age.

The study confirms the general trend of the polar-wandering curve for North America obtained by Runcorn, which lies around the northern Pacific Ocean: the pole being in the central tropical Pacific in late Precambrian time, moving across to the tropical western Pacific in the early Paleozoic and to Asia in the late Paleozoic and early Mesozoic. The data also show that the polar-wandering curve for North America is displaced westward relative to that for Europe, as Runcorn showed, and provide an estimate for the amount of drift between the 2 continents since Mesozoic time, which is of the order of 30° long.--Auth.

2-2593. Opdyke, N.D., and S.K. Runcorn. WIND DIRECTION IN THE WESTERN UNITED STATES IN THE LATE PALEOZOIC: Geol. Soc. America, Bull., v. 71, no. 7, p. 959-971, 5 illus., 2 maps, 5 graphs, 2 tables, July 1960, 38 refs.

From paleomagnetic surveys the latitude and orientation of Great Britain and the United States relative to the axis of rotation have been inferred for successive periods in the geological column. The question then arises whether these positions agree with those indicated by paleoclimatic studies. Assuming that a trade-wind belt has been a feature of the general circulation of the atmosphere throughout geological time, an important test is to determine the ancient wind directions by the study of eolian sandstones. Determinations of the directions of dip of the large-scale cross-stratified parts of the Tensleep, Casper, and Weber formations of Permo-Pennsylvanian age in the western United States are described. These sandstones are considered to be eolian, in which case the inferred wind directions and the results of paleomagnetism agree.--Auth.

2-2594. Cook, John C. RF ELECTRICAL PROPERTIES OF SALTY ICE AND FROZEN EARTH: Jour. Geophys. Research, v. 65, no. 6, p. 1767-1771, 2 diags., 2 tables, June 1960, 7 refs.

RF losses at 100 Mc/s in artificial samples of salty ice and frozen, fresh-water-saturated earths were measured in the laboratory, and pronounced attenuation of radio waves within distances of a few meters are predicted as a general rule. Salty ice dielectric constants averaged 3.5, and resistivities 'across the grain' varied from about 55 ohmmeters at −10°C. to about 1,200 ohmmeters at −40°C. for ice containing about 5‰ of salts. These results may or may not apply to natural sea ice and permafrost. --Auth.

2-2595. U.S. Dept. of State. THE NEED FOR FUNDAMENTAL RESEARCH IN SEISMOLOGY. REPORT OF THE PANEL ON SEISMIC IMPROVEMENT 214 p., diags., graphs, tables, [Washington, D.C.], July 1959.

The report of the Panel on Seismic Improvement appointed by the Special Assistant to the President to review the feasibility of improving the Geneva control system to detect and identify underground events. The strategic requirements of detection and the need to maintain position in the field of seismology make necessary greatly increased support for research. The various phases requiring special priority fall into the following broad fields: conditions at the source, effects of transmission through the earth, instrumentation for recording seismic signals, and improvement of data processing.--M. Russell.

The summary report is based on the following separate reports which are included as appendices:

Press, Frank and David T. Griggs. Improved quipment for Existing Seismic Stations, p. 17-18.
Romney, Carl F. Short Period Shear Waves and heir Application to Discriminating Between Earth-akes and Explosions, p. 19-21.
Gerrard, John. Unattended Auxiliary Seismic lations, p. 22-41.
Press, Frank. Aftershocks as Means of Identifi-ation of Earthquakes, p. 42.
Press, Frank. Long Period Surface and Body aves, p. 43-45.
Knopoff, Leon. Deductive Seismology, p. 46-51.
Street, Kenneth, Jr. Need for High Explosive and uclear Tests for Research Program, p. 52-57.
Oliver, Jack E. Seismic Waves in the Intermedi-e Period Range, p. 58-59.
Tukey, John W. Equalization and Pulse Shaping echniques Applied to the Determination of Initial ense of Rayleigh Waves, p. 60-129.
Oliver, Jack E. The Phase Compensation Method Equalization, p. 130-131.
Press, Frank and David T. Griggs. Geophysical vestigation of Continental Crustal Structure, p. 32-133.
Oliver, Jack E. Ocean Bottom Seismographs, p. 34-136.
Benioff, Hugo. Suggestions for Standards of Noise, mplitude, and Spectrum, p. 137-138.
Benioff, Hugo. Improved Seismographs, p. 139-14.
Gerrard, John. "Throw-Away" or Portable Seis-ic Probes for Operation on Land, p. 145-152.
Gerrard, John. Use of Multiple Arrays in Seis-ic Detection, p. 152-163.
Gerrard, John. Data-Processing Requirements, . 164-183.
Gerrard, John. Program to Establish a Complete xperimental Seismic Station for the Evaluation of etwork Instruments and Methods, p. 184-185.
Romney, Carl F. Deep Hole Detection Tech-iques, p. 186-192.
Gerrard, John. Research Computing Facilities nd a Digital Library of Seismograms, p. 193-194.
Gerrard, John. Considerations on the Standard-zation of Seismometers to be Used in the Geneva etwork, p. 195-214.

-2596. Shea, Gerald J. NORMAL EARTHQUAKES ND RECORDS OF TREMORS IN THE EARTH'S OTATION: Indiana Acad. Sci., Proc., v. 68, p. 98-299, 1958, pub. 1959.

Seismographs in Terre Haute, Indiana, prior to 953 consisted of 2 modified Bosch-Omori instru-nents oriented N.-S. and E.-W. After 1953 a modi-ied Milne-Shaw seismograph was installed. The stelar seismometer," a telescope lens of long focal ength provided with a recording drum and photograph-c film, has been developed to record minute tremors ssociated with rotation of the earth.--M. Russell.

-2597. Shurbet, D.H. THE P PHASE TRANS-MITTED BY CRUSTAL ROCK TO INTERMEDIATE ISTANCES: Jour. Geophys. Research, v. 65, no. , p. 1809-1814, map, 2 diags., June 1960, 7 refs.

A strong $\bar{P}$ phase recorded at Lubbock, Texas, is dentified as a wave-guide phase. The phase is called and it is shown that it is the longitudinal wave cor-esponding to L_g. Some evidence is presented to sup-ort the hypothesis that the lower boundary of the ave guide is due to increasing velocity with depth, ather than to an interface, and that the upper bound-ry of the wave guide is the free surface.--Auth.

2-2598. Nanda, J.N. THE ORIGIN OF MICRO-SEISMS: Jour. Geophys. Research, v. 65, no. 6, p. 1815-1820, June 1960, 10 refs.

In 1944 Miche developed a theory to explain the production of a bottom pressure due to standing waves on the surface of the sea, and in 1950 Longuit-Higgins accounted for microseisms by widespread in-phase pressure oscillations. According to this theory the groups of waves moving in opposite directions, generated by storms or by wave action near the coastline give standing waves. In this paper an alternative origin is suggested. It is the action of suitably oriented winds with rough sea surface. The author has earlier described the sea roughness as having a certain periodicity. Such periodicity can be caused by the existence of standing waves, but it can also arise in other ways; for example, the amplitude of the progressive waves might be a periodic function of time, the period being the same as the period of the corresponding microseisms. In such a case the interaction of the convergent winds under a storm, or of winds parallel to a coastline, will bring about oscillations in the sea surface which will be transmitted through the ground as microseisms.

The wind interaction term is about 1/100 of the Miche term, but still this is more than that required to account for the observed microseisms. The amplitude is inversely proportional to the depth of the sea, and is very sensitive to the speed of the oriented winds.--Auth.

2-2599. Alekseev, A.S. SOME LAWS ON THE PROPAGATION OF WAVES IN A NON-UNIFORM MEDIUM. Translated by H.P. Thielman: Internat. Geology Rev., v. 2, no. 6, p. 530-532, June 1960, 6 refs.

A mathematical analysis is presented of the effects of irregularities on seismic waves in the propagating medium. Formulas expressing the behavior of such waves are derived. The existence of a series of reflected waves, in addition to the direct waves, is deduced near the boundary of irregularities.--M. Russell.

2-2600. Babich, V.M., and A.S. Alekseev. ON THE SCREENING EFFECT OF A THIN ELASTIC LAYER. Translated by H.P. Thielman: Internat. Geology Rev., v. 2, no. 6, p. 527-529, diag., June 1960, 3 refs.

Waves falling on thin layers at angles greater than the limiting angle of complete internal reflection, contrary to the rules of geometric optics, do pass through a screening layer to an extent which is in inverse proportion to the thickness. A mathematical analysis of the screening effects by these layers confirms the applicability of the dynamic theory of elasticity in seismology.--M. Russell.

2-2601. Keylis-Borok, V.I. ASYMMETRIC INTERFERENCE WAVES IN A LAMINATED MEDIUM. Translated by H.P. Thielman: Internat. Geology Rev., v. 2, no. 7, p. 577-581, July 1960, 3 refs.

Investigation of axial-symmetric interference waves in a multilayered half space is extended to the problem of asymmetric oscillations. The solution presented is in analogous form to that of the author's axial-symmetric problem. The method of solution is based on a problem that involved a homogeneous half space: the solution is expressed as Fourier double integrals in terms of x, y, and then reduced

to single integrals of the Fourier-Bessel type. In the asymmetric case of excitation, analysis of formulas expressing displacement shows the principal component of the displacement to be separated into waves of 2 types: 1) those analogous to axial-symmetric waves, whose displacements lie in the vertical plane; and 2) those having horizontal, tangential displacements, a special case of Love waves. Apparently, simultaneous generation of these wave types is investigated for the first time in this work. Their similarity to volume waves is substantiated here. The relations derived make it possible to separate the influence of properties of the medium from those of the source upon the asymmetry of surface waves (in particular, upon the relationship between Rayleigh and Love waves). Possibly, this study might be applicable to research on surface-wave absorption in the earth's crust as well as on dynamical properties of a disturbance focus. The formula given for Love-wave intensity is considered to be especially applicable to investigation of the structure of laminated media, on the basis of resonance phenomena. --D. D. Fisher.

2-2602. Knopoff, Leon, and Gordon J. F. MacDonald. MODELS FOR ACOUSTIC LOSS IN SOLIDS: Jour. Geophys. Research, v. 65, no. 7, p. 2191-2197, 6 diags., July 1960, 6 refs.

A macroscopic model for the attenuation of small-amplitude stress waves in solids is presented. The loss mechanism described is that of solid friction which varies as the gradient of the local stress. The model is illustrated by a mass-spring system sliding on a rough surface in which the roughness of the surface increases in either direction with distance from the equilibrium position of the mass. The Q for the model is independent of frequency. Experimental evidence for the dependence of Q on surface area in silicate aggregates suggests the validity of a solid-friction model.--Auth.

2-2603. Hobson, George D. A RECONNAISSANCE SEISMIC REFRACTION AND REFLECTION SURVEY IN SOUTHERN ONTARIO: Can. Mining Jour., v. 81, no. 4, p. 83-86, 2 illus., Apr. 1960, 5 refs.

Seismic survey work by the Geological Survey of Canada during 1959 in that part of southern Ontario underlain by Paleozoic strata is described. Technical details are briefly noted. Observations were made at 107 stations within a belt approximately 25 mi. wide extending from Havelock to Petrolia. The applicability and limitations of seismic methods of determining the depth to various marker horizons is given.--W. C. Peters.

2-2604. Båth, Markus. CRUSTAL STRUCTURE OF ICELAND: Jour. Geophys. Research, v. 65, no. 6, p. 1793-1807, 2 illus., map, 5 diags., 5 tables, June 1960, 12 refs.

A report is given of the results of a seismic field investigation in 1959 of the crustal structure of Iceland. Explosions were made at a depth of 30 m. in Graenavatn, a crater lake in SW. Iceland, and recordings were made with a 12-channel refraction apparatus at a number of stations along 2 profiles across Iceland, 1 profile across the center of the island and another in the western part. A 3-layered crust was found - a top layer of lava and volcanic ash and 2 basaltic layers. The longitudinal wave velocities are 3.69, 6.71, and 7.38 km./sec., respectively, and the layer thicknesses 2.1, 15.7, and 10.0 km., respectively. The total crustal thickness down to the Mohorovičić discontinuity is around 27.8 km. Direct waves through the various layers, as well as reflected waves, are used in the study. Longitudinal guided waves, propagated by multiple reflections in the lava layer, were recorded out to distances of over 100 km. As a consequence of the large velocity contrast between the lava layer and the first basaltic layer, more than 83.5% of the original seismic energy remains in the lava layer, leaving only a few per cent to penetrate deeper. Amplitude attenuation coefficients have been determined, which are about twice as large for the central profile as for the western profile. The main reason for the strong attenuation along the central profile is scattering of the waves in the inhomogeneous and heavily fractured crust. The seismic efficiency of the explosions, all carried out in the same way, varies in the mean by 20 to 25%, as evidenced by the records of the Reykjavik seismograph station.--Auth.

2-2605. Dohr, Gerhard. USE OF REFLECTION-SEISMIC METHODS IN THE EXPLORATION OF DEEP BEDS. Translated by T. Gretener: Internat. Geology Rev., v. 2, no. 7, p. 617-622, 3 graphs, 2 seismograms, July 1960, 13 refs.

Observation of reflections reported from very great depths, from reflection-seismic measurement by Seismos GmbH. (that were commissioned by the Preussischen Bergwerks-und Hütten AG., Mobiloil AG. in Germany, and by Wintershall AG. in various project districts of Germany) will be discussed. The most salient groups, most probably, could be related to the Conrad and Mohorovičić discontinuities.--Auth.

2-2606. Drwila, St., and Jan Zytka. RESULTS OF RESEARCH IN THE CARPATHIAN FORELAND AREA. Prepared by U.S. Joint Publications Research Service: Internat. Geology Rev., v. 2, no. 6, p. 522-526, 5 figs. incl. 2 maps, June 1960.

The known existence of anticlinal, potentially oil-producing, structures in Tertiary formations in adjacent Soviet areas prompted a seismic survey to determine whether extensions of these, and possibly other similar structures, exist in the Polish Carpathian foreland. Numerous domal structures, associated with faults, were mapped.--M. Russell.

2-2607. Danes, Z. F. A CHEMICAL CORRECTION FACTOR IN GAMMA-GAMMA DENSITY LOGGING: Jour. Geophys. Research, v. 65, no. 7, p. 2149-2153, 2 diags., graph, log., table, July 1960, 4 refs.

Log-derived rock densities may be in error for 2 reasons: 1) the ratio of A/Z varies for various chemical elements; 2) the photoelectric absorption, neglected in calibration, may become appreciable if heavier elements are present. The effects are discussed and the A/Z correction factors calculated.--Auth.

2-2608. Melbye, Charles E. GEOPHYSICS IN THE ROCKY MOUNTAIN AREA: Mining World, v. 22, no. 7, p. 37-40, June 1960.

Recent gains of mining geophysics in the Rockies offset an earlier lag. [This] review of recent developments is arranged by types of deposits and research applications thereto, rather than by geophysical methods.--Worldwide Mining Abstracts, v. 7, no. 4, p. 7, July-Aug. 1960, abs. 74-B21.

-2609. Hales, A.L. SEISMIC AND GRAVITY ESEARCH ON CRUSTAL STRUCTURE IN SOUTH FRICA: Jour. Geophys. Research, v. 65, no. 7, . 2155-2168, 2 illus., map, 6 profiles, 9 diags., ɔg., July 1960, 34 refs.

Seismic observations in the eastern Transvaal ave shown that a) there is an 'intermediate layer' this region, b) the P_n travel times are earlier for ie coastal plain than for the high plateau as would e expected if the plateau were isostatically compen- ated. The relationship between crustal structure nd isostatic equilibrium is discussed.

Analysis of the isostatic anomaly field in South Africa leads to the conclusion that a crustal thickness of 30 to 40 km. is consistent with the gravity data. It is pointed out that the anomalies on the seaward side of the escarpment bounding the interior plateau of South Africa are predominantly negative. It is suggested that in some areas the negative anomalies are due to the still existing roots of the former topography, and inferences are made with regard to the strength of the mantle and crust. It is suggested that heat generated by plastic deformation may account for the association of volcanicity with regions of high stress.--Auth.

7. GEOCHEMISTRY

ee also: Structural Geology 2-2512; Stratigraphy -2535; Sedimentary Petrology 2-2658; Mineral Deposits -2682 through 2-2688.

-2610. Taylor, S.R. THE ABUNDANCE OF THE ARE EARTH ELEMENTS IN RELATION TO THEIR RIGIN: Geochim. et Cosmochim. Acta, v. 19, no. , p. 100-112, 5 diags., 5 tables, Apr. 1960, 33 refs.

The abundances of the rare earth elements given y Suess and Urey are correlated with the processes f formation of the individual nuclides listed by Burridge et al. It is shown that the smoothing process arried out by Suess and Urey leads to relative de- ression of the s-process nuclides and elevation of ıose formed by the r-process. Later abundances ublished by Cameron accentuate this trend. His e/Nd ratio necessitates major fractionation between ıe earth and chondrites.--Auth.

-2611. Ernst, Wallace G. THE STABILITY RE- ATIONS OF MAGNESIORIEBECKITE: Geochim. et osmochim. Acta, v. 19, no. 1, p. 10-40, 12 diags., 5 tables, March 1960, 50 refs.

Magnesioriebeckite, $\square Na_2Mg_3Fe_2^{3+}Si_8O_{22}(OH)_2$, as been synthesized hydrothermally and its stability eld determined. The physical parameters which etermine experimental phase equilibria include the artial pressure of O as well as the temperature and apor (= total, largely H_2O) pressure.

The stability field of magnesioriebeckite is bounded y surfaces within a P_{O_2}-P_{vapor}-T volume. vapor-T diagrams represent projections along the $_{O_2}$ axis. Three P_{vapor}-T diagrams are presented or magnesioriebeckite, each determined using a dif- erent buffer. At low vapor pressure, magnesiorie- eckite breaks down to a high-temperature assem- lage consisting of one or two iron (+ Mg) oxides, an lvine, $Na_2O \cdot 5(Mg, Fe)O \cdot 12SiO_2$, acmite or Na_2- $\cdot 2(Mg, Fe)O \cdot 6SiO_2$, and vapor. At vapor pressures reater than about 200 bars, magnesioriebeckite nelts incongruently to one or two iron (+ Mg) oxides, n olivine, $Na_2O \cdot 5(Mg, Fe)O \cdot 12SiO_2$, liquid and apor. Above 300 to 500 bars vapor pressure, mag- esioriebeckite melts incongruently to one or two ron (+ Mg) oxides, an olivine, an orthopyroxene, quid and vapor.

Values of ΔH for reactions involving magnesiorie- eckite have been calculated; heats of reaction are milar to those for the breakdown of other hydrous inerals. Optical properties of synthetic magne - oriebeckite vary in response to P_{O_2} and T. The ffect of the partial O pressure on the composition nd stability relations of minerals synthesized in is study again illustrates the petrologic importance this variable.

Results of the investigation indicate that magnesioriebeckite is stable at magmatic temperatures; the existence of an intermediate member of the magnesioriebeckite-riebeckite series as an authigenic mineral suggests that magnesioriebeckite is also stable at very low temperatures. Since it has a wide P_{vapor}-T range, the restricted natural occurrence of magnesioriebeckite results chiefly from the rare fulfillment of hypersodic chemical conditions.--Auth.

2-2612. Moruzzi, V.L., and M.W. Shafer. PHASE EQUILIBRIA IN THE SYSTEM La_2O_3-IRON OXIDE IN AIR: Am. Ceramic Soc., Jour., v. 43, no. 7, p. 367-372, 12 illus., 2 diags., 2 tables, July 1960, 9 refs.

Phase equilibria data are presented for compositions in the system La_2O_3-iron oxide in air. Liquidus and solidus curves were obtained by the quenching method in the Fe-rich portion of the system. The remainder of the diagram was determined using a strip-furnace technique. Two compounds have been found, the orthorhombic perovskite $LaFeO_3$ and a compound with the magnetoplumbite structure corresponding to a composition $LaFe_{12}O_{19}$. $LaFeO_3$ was determined to melt congruently at about 1,890°C. whereas $LaFe_{12}O_{19}$ has both a stability minimum and maximum at 1,380° and 1,421°C., respectively. The Fe-rich portion of the system is essentially ternary whereas the remainder can be considered to be a simple binary. Liquid compositions have been determined and are plotted in terms of the ternary system La_2O_3-Fe_2O_3-FeO.--Auth.

2-2613. Shternina, E.B. SOLUBILITY OF GYPSUM IN AQUEOUS SOLUTIONS OF SALTS. Translated by A.J. Shneiderov: Internat. Geology Rev., v. 2, no. 7, p. 605-616, 7 diags., 11 tables, July 1960, 12 refs.

The system $CaSO_4$-NaCl-H_2O-CO_2, part of the system $CaCO_3$-$CaSO_4$-NaCl-H_2O-CO_2, was investigated through a range of NaCl concentrations. Calcite and gypsum solubilities were studied under conditions approximating those of the natural environment as closely as possible, for the particular purpose of determining the behavior of slightly soluble salts in the presence of readily soluble salts. In that even their saturated solutions remain dilute, concentration of calcite and gypsum is insignificant compared to that of NaCl. From a moderate amount of experimental data, then, it was possible to compute the solubility diagram for a complex system through application of the equations of Debye and Hückel. The Debye-Hückel approximate equation was found to

be best suited to the purposes of this experiment. Solubility of gypsum in aqueous NaCl solutions (up to saturation) was calculated according to these equations. If a system goes to equilibrium very slowly, which is the case here, investigation is much simplified when it is possible to find the solubility by calculation. Mean effective ion diameters were assumed to be a function of concentration. A linear equation was obtained for the system $CaSO_4$-NaCl-H_2O, to describe the relation between effective ion diameters and NaCl content. A method of calculation to determine gypsum solubility was verified for several similar systems according to experimental data from various authors. An approximate form is given for experimental linear equations for correlation of effective ion diameters with concentrations. It is possible that crystallographic dimensions of ions as well as solubility of added salts, constitute bases for an attempt to explain the complexity of dependence of the mean effective ion diameters upon concentration of systems that are composed of gypsum and aqueous solutions of readily soluble salts with no ions common to gypsum or ability to react chemically with it.--D.D. Fisher.

2-2614. MacDonald, Gordon J.F., and Norman F. Ness. STABILITY OF PHASE TRANSITIONS WITHIN THE EARTH: Jour. Geophys. Research, v. 65, no. 7, p. 2173-2190, 15 diags., 3 tables, July 1960, 21 refs.

It is assumed that the Mohorovičić discontinuity defining the base of the crust is a phase transition separating basalt from eclogite. The movement of such a phase transition resulting from changing mechanical and thermal conditions associated with sedimentation and erosion is examined. The equilibrium states of crusts having a wide range of thermal properties are calculated on the assumptions that isostatic equilibrium is maintained and that thermal equilibrium is attained. As an example, the deposition of 10 km. of low-conductivity sediments on a crust initially 35 km. thick will result in the conversion of 5 km. of the crust to mantle material and the elevation of the initial surface of sedimentation of 2 km. above sea level provided that the phase boundary is approximated by the pyrope-garnet transition. The time scale for the deposition and subsequent elevation of the sediments is of the order of 10^8 years.

The 1-dimensional field equations describing the flow of heat in the mantle and crust, together with appropriate boundary conditions, have been approximated by finite difference equations. The equations have been solved numerically on an IBM 704. In these calculations various models for sedimentation have been studied but isostatic compensation has been neglected. As an example, a basin initially 3 km. deep receives sediments at a rate inversely proportional to the depth of sedimentation. After 4×10^6 years the basin is filled with 4 km. of sediments and the phase boundary moves upward from an initial depth of 30 km. to a depth of 24 km. The sediments then rise above sea level as the phase boundary moves downward. The maximum uplift of the sediments above sea level is 610 m., and this level is maintained for times greater than 4×10^7 years. The time scale for the process is large both because of the large thermal time constant of the crust and sediments and because of the slowly changing geometrical distribution of the thermal parameters.

The amplitudes and time scales of the motion of the phase boundary and outer surface are in general accord with geological observations. The calculations cannot be used to rule out the possibility that the Mohorovičić discontinuity is a phase transition, nor are the calculations extensive enough to support a detailed theory of plateau and mountain formation. --Auth.

2-2615. Anders, Edward. THE RECORD IN THE METEORITES - II. ON THE PRESENCE OF ALUMINIUM-26 IN METEORITES AND TEKTITES: Geochim. et Cosmochim. Acta, v. 19, no. 1, p. 53-62, diag., 3 graphs, 2 tables, March 1960, 19 refs.

A search for cosmic-ray produced Al^{26} has been undertaken in meteorites and tektites, using γ-γ coincidence spectrometry. The sensitivity and specificity of this method were sufficient to permit nondestructive measurement of Al^{26} in a 70 g. specimen of the Plainview chondrite; the specific activity found, 0.058 ± 0.005 positrons $min.^{-1}$ $g.^{-1}$, agrees well with the value of Ehmann and Kohman. In the case of tektites, chemical separation of the Al fraction was required because of interference by the U and Th series. Although a very small amount of activity was found in the Al fraction from an australite, corresponding to an apparent Al^{26} content of 0.005 ± 0.009 positrons $min.^{-1}$ $g.^{-1}$, and a "flight time" of $1.1 \pm 2.0 \times 10^5$ years, it is shown that even this low counting rate was due to some contaminant, rather than Al^{26}. Corrected for this contaminant, the counting rate becomes 0.000 ± 0.009 positrons $min.^{-1}$ $g.^{-1}$, and the upper limit for the Al^{26} content of australites, ≤ 0.022 disintegrations $min.^{-1}$ $g.^{-1}$ in contrast to the Ehmann and Kohman value of 0.040 ± 0.011. This limit corresponds to a "flight time" of $\leq 5 \times 10^5$ years. In view of this result, a terrestrial origin of tektites has once more become a possibility.--Auth.

2-2616. Schaeffer, Oliver A., and J. Zähringer. HELIUM, NEON AND ARGON ISOTOPES IN SOME IRON METEORITES: Geochim. et Cosmochim. Acta, v. 19, no. 2, p. 94-99, diag., 2 tables, Apr. 1960, 21 refs.

The cosmic ray produced He^3, He^4, Ne^{20}, Ne^{21}, Ne^{22}, Ar^{36}, and Ar^{38} have been measured in 7 Fe meteorites with varying He contents. The results on isotope abundance agree well with previous results. By considering the He^3/He^4, He^3/Ne^{21}, and He^3/Ar^{38} ratios it is shown that it may be possible to determine the depth at which a sample was in the original meteoroid from these ratios, rather than from the absolute amount of any particular isotope.--Auth.

2-2617. Schindewolf, U. SELENIUM AND TELLURIUM CONTENT OF STONY METEORITES BY NEUTRON ACTIVATION: Geochim. et Cosmochim. Acta, v. 19, no. 2, p. 134-138, 2 tables, Apr. 1960, 9 refs.

By neutron activation analysis the Se- and Te-content of 4 chondritic meteorites have been determined. The average content is 9.8 ± 2.5 and 0.61 ± 1.7 p.p.m. respectively. These values are lower than those already reported in the literature.--Auth.

2-2618. Jeffery, P.G. THE SILICA AND ALUMINA CONTENT OF THE STANDARD ROCKS G-1 AND W-1: Geochim. et Cosmochim. Acta, v. 19, no. 2, p. 127-133, 2 tables, Apr. 1960, 21 refs.

In a review of some recent determinations of alumina and silica in the 2 standard rocks G-1 and W-1 it is shown that some of the values reported for these

kides agree closely with revised values calculated om the original data for these rocks and for a hap- granite glass.--Auth.

-2619. Vincent, E.A., and L.I. Bilefield. CAD- IUM IN ROCKS AND MINERALS FROM THE SKAER- AARD INTRUSION, EAST GREENLAND: Geochim. Cosmochim. Acta, v. 19, no. 1, p. 63-69, diag., tables, March 1960, 10 refs.

Traces of Cd have been determined by neutron ctivation analysis in a suite of rocks from the Skaer- aard intrusion, E. Greenland, and in the separated inerals from one of them. The original parent basic nagma contained 0.13 p.p.m. Cd, and progressive ractional crystallization led slowly to a twofold in- rease in the ferrogabbros and a fourfold increase n the granophyres derived largely from the ultimate esidual magmatic fractions. Cd does not appear to nter immiscible copper and iron sulfide droplets in ne magma in preference to silicates and oxides, either does it show any marked preference among ne latter. Despite similar ionic radius and charge, Cd^{2+} does not follow Ca^{2+} in plagioclase and apatite, ut is slightly concentrated in Fe-rich pyroxene, livine, and titaniferous magnetite. Most of the Cd ecomes concentrated in the residual magmatic liquids.

The values for Cd found by the neutron activation ethod in the standard rocks G-1 and W-1 were 0.06 .p.m. and 0.33 p.p.m., respectively.--Auth.

-2620. Krinsley, David H. TRACE ELEMENTS N THE TESTS OF PLANKTONIC FORAMINIFERA: Micropaleontology, v. 6, no. 3, p. 297-300, 2 ta- les, July 1960, 16 refs.

Seven trace elements - Mn, Ti, Al, Mg, Sr, Cu, nd Ni - were examined in the tests of planktonic oraminifera in cores from the Atlantic Ocean. Mn oncentrations appear to be related to geographic ocation; Cu is probably stable in planktonic foramin- feral tests.--Auth.

-2621. Goldberg, Edward D., and Robert H. Parker. PHOSPHATIZED WOOD FROM THE PACIF- C SEA FLOOR: Geol. Soc. America, Bull., v. 71, o. 5, p. 631-632, 2 profiles, May 1960, 5 refs.

A sample of phosphatized wood was dredged from 410-m. terrace in the Gulf of Tehuantepec by the cripps Institution of Oceanography, Tuna Oceano- raphic Cruise TO-58-2, at Station D-7. The nineral portion of the wood, determined by X-ray iffraction, is similar to marine carbonate-fluor- patites, $Ca_{10}(PO_4, CO_3)_6F_{2-3}$. A C-14 age deter- nination indicates an age greater than 28,000 ears. The sea water at the 400-m. level is haracterized by a low dissolved-O content, high rganic content, and maximal P values. The condi- ions of phosphatization are reconstructed from the ea-water chemistry determined at the station. U nd Th contained in the phosphatized wood measured 3 and 0.2 p.p.m. respectively. It is presumed that etravalent ions of U and Th substituted directly for Ca in the apatite lattice, their ionic radii being nearly dentical. It is concluded that the activities of Th^{+4} nd U^{+4} in the reducing environment of apatite for- nation are of the same order of magnitude as the oncentrations of these elements in sea water.--B.W. ipkin.

-2622. Fechtig, H., W. Gentner, and J. Zäh- inger. ARGONBESTIMMUNGEN AN KALIUMMIN- ERALIEN - VII. DIFFUSIONSVERLUSTE VON AR- GON IN MINERALIEN UND IHRE AUSWIRKUNG AUF DIE KALIUM-ARGON-ALTERSBESTIMMUNG [AR- GON DETERMINATION ON POTASSIUM MINERALS - VII. DIFFUSION LOSS OF ARGON IN MINERALS AND ITS EFFECT ON POTASSIUM-ARGON AGE DETERMINATIONS]: Geochim. et Cosmochim. Acta, v. 19, no. 2, p. 70-79, illus., 4 diags., 2 tables, March 1960, 17 refs.; abs. in English, text in German.

In Ca-containing minerals Ar^{37} was produced with the aid of a (n, α) reaction and the diffusion of Ar^{37} was measured as a function of temperature. Owing to the high sensitivity of this method it was possible to measure diffusion constants down to room temperature. For fluorite, anorthite, augite, and margarite the diffusion constants determined at room temperature are 10^{-21}-10^{-25} $cm.^2/sec$. These results are in agreement with those obtained by the K-Ar age determination. The shape of the curves $\bar{D}(1/T)$ shows 2 knees which account for the discrepancy of the values obtained by other methods through extrapolation. --Auth.

2-2623. Catanzaro, E.J., and Paul W. Gast. ISOTOPIC COMPOSITION OF LEAD IN PEGMATITIC FELDSPARS: Geochim. et Cosmochim. Acta, v. 19, no. 2, p. 113-126, 2 diags., 7 tables, Apr. 1960, 35 refs.

An ion-exchange method was developed for extracting microgram quantities of Pb from pegmatitic feldspars. The isotopic composition of Pb in feldspars ranging from 350 to 2,750 million years (m.y.) in age was determined. Model ages were calculated and were generally found to be in good agreement with independent age determinations. The results are compatible with a Pb model stipulating relatively short periods of time in a crustal environment for the Pb.

In one instance where there was a large discrepancy between the model age and the known age, because of excess radiogenic Pb in the feldspar, the anomaly was resolved by acid leach experiments which preferentially removed the excess radiogenic Pb.

The Pb content of 25 feldspars was measured and found to range from <20 p.p.m. to 500 p.p.m.--Auth.

2-2624. Russell, R.D., and R.M. Farquhar. DATING GALENAS BY MEANS OF THEIR ISOTOPIC CONSTITUTIONS - II: Geochim. et Cosmochim. Acta, v. 19, no. 1, p. 41-52, 4 diags., 4 tables, March 1960, 16 refs.

Recently a rather large number of analyses of common Pb samples has become available, and these in turn have lead to a better understanding of the precise nature of the physical and geological processes resulting in the observed variations of Pb isotope ratios. Specifically, there now appear to be 3 classes of leads, each of which has Pb isotope ratios that vary in a remarkably simple pattern. These are meteoritic leads, anomalous leads, and leads from certain conformable Pb ore deposits. The meteoritic leads and conformable leads both appear to have developed in surroundings where Th and U have very similar properties, and in both cases the Th to U ratio corresponds to a present value of 3.73 ± 0.03. This is taken to be evidence that both classes developed under predominantly reducing conditions. In contrast, the presence of Th to U ratio present during the production of anomalous leads is extremely vari-

able, suggesting an oxidizing environment. It has been suggested that all vein leads may be anomalous to some degree and therefore should be interpreted with this possibility in mind.

The methods for dating galenas proposed previously by the present writers are reexamined in view of these developments and it is shown that they may lead to more explicit information on the age and history of Pb ores than has usually been obtained.--Auth.

2-2625. Herzog, Leonard F. AGE DETERMINATION BY X-RAY FLUORESCENCE RUBIDIUM-STRONTIUM RATIO MEASUREMENT IN LEPIDOLITE: Science, v. 132, no. 3422, p. 293-295, table, July 29, 1960, 6 refs.

X-ray fluoresence analysis of several lepidolites whose Rb and Sr concentrations had already been determined by neutron activation and stable isotope dilution, or both, indicates that this technique can be used for rapid nondestructive reconnaissance Rb-Sr studies, and that an X-ray analysis method comparable in accuracy to isotope dilution can probably be developed for dating Precambrian lepidolites, as the simple technique presently used has many obvious possibilities for improvement.--Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Geomorphology 2-2496; Sedimentary Petrology 2-2657.

2-2626. Comer, Joseph J. THE ELECTRON MICROSCOPE IN THE STUDY OF MINERALS AND CERAMICS (In: Am. Soc. Testing Materials. Symposium on Microscopy: ASTM Spec. Tech. Pub. no. 257, p. 94-120, 22 illus., 3 diags., 1959) 43 refs.

Important advances in electron microscopy have been made in instrument design and performance as well as in specimen preparation techniques. Greater emphasis is now being placed on fine structural details which were not able to be resolved in earlier studies. A resolving power as low as 8 Å can be obtained in direct observations of the specimen, while the lowest possible resolution with a replica technique is about 20 to 30 Å.

Particular attention is being paid to fine structure in clay minerals, glasses, and other ceramic materials. Examination of bulk clays has revealed details that are important in attempting to define the natural state of the mineral and has helped to provide logical explanations for some of the physical and chemical properties of importance when they are used as catalysts and in the manufacture of certain products in which clays play an important part. Surface details on glasses show fracture paths, liquid immiscibility, location and size of nucleating agents, weathering effects, and the effects of chemical surface treatments. In the study of ceramic bodies, electron micrographs of fractured specimens show how surface topography is related to particle size of the raw clay, the presence of impurities, and the firing temperature.

During examinations of clays and other minerals are made for the determination of particle size distributions, the determination of the morphology of individual particles, or the determination of the state of aggregation of a specimen. The electron microscope can be converted readily for electron diffraction studies using an aperture system which permits one to "select" diffraction patterns from areas of over 30μ down to less than 2μ in diameter. One of its important uses is in the identification of small quantities of impurities in samples which by X-ray diffraction may appear to be "pure." It is used also in the study of single crystals to obtain information on unit-cell parameters of compounds whose crystal size is so small as to preclude single crystal X-ray analysis.

This paper shows by a few specific illustrations how the electron microscope has helped to correlate morphology, and in particular surface structure, with physical properties or behavior as determined by other methods of study.--From auth. introd.

2-2627. Cameron, Eugene N. THE STUDY OF OPAQUE MINERALS IN REFLECTED LIGHT (In: Am. Soc. Testing Materials. Symposium on Microscopy: ASTM Spec. Tech. Pub. no. 257, p. 39-75, 14 illus., 8 diags., table, 1959) 76 refs.

The study of opaque minerals in reflected light is a basic technique for investigation of metallic ores. In geology and mineralogy it has an important role in identification of the minerals of ores, in analysis of textural relations, and in recognition of stages and processes of mineral deposition. In the mineral industries, it is employed in studies of mill products aimed at design, improvement, or control of mineral dressing procedures.

In ore microscopy, mineral identification is based largely on study of physical, optical, and chemical properties. Physical properties investigated are crystal form and habit, cleavage and parting, scratch hardness, indentation hardness, polishing hardness, and tenacity. Much attention is currently being given to determinations of indentation hardness.

Ore minerals comprise both isotropic and anisotropic substances. For isotropic minerals, the fundamental constants are the index of refraction and index of absorption, but neither can readily be determined with the microscope. Color and reflectivity relative to associated minerals are the properties commonly observed, but reflectivity is also quantitatively determinable by photometric or photoelectric methods.

For anisotropic minerals, color, bireflectance, reflectivity, and elongation, together with anisotropism and polarization colors both in air and in oil, can be determined qualitatively in polarized light, and some minerals can be identified solely from such observations. Dispersion phenomena of polarization figures are likewise of value. Quantitative work has consisted largely of measurements of either mean or uniradial reflectivities. Apparatus is available, however, for quantitative analysis of elliptically polarized light, by measurement of the rotation angle and path difference, and by determination of the sign of the path difference. Theory indicates that optical symmetry may be determinable for some minerals. Existing apparatus needs improvement for accurate measurement of path differences.

Chemical etching and qualitative tests for specific elements are both employed in mineral identification. Etching is also used for revealing textural features. Tests for specific elements are made either on mineral samples gouged or drilled from polished sections or by contact printing from polished sections.

X-ray diffraction methods are important adjuncts to ore microscopy and have supplanted microchemi-

al tests to a considerable extent. Spectrographic nd spectrometric methods, though less widely used, ave many actual and potential applications. In the tudy of ores, X-ray and spectrographic methods are specially effective if used in conjunction with microcope study, which gives essential information on the istribution and relationships of minerals in ores.

In future work in ore microscopy, it seems safe o predict that there will be increasing emphasis on uantitative measurement of microhardness and opical properties as aids to identification. The joint se of ore microscopy, X-ray methods, and spectroraphic methods also seems likely to be extended, or the combination of techniques can furnish soluions to a wide range of problems encountered in eology, mineralogy, and mineral dressing.--Auth.

-2628. Cuttitta, Frank, Robert Meyrowitz, and Betsy Levin. DIMETHYL SULFOXIDE, A NEW DILUENT FOR METHYLENE IODIDE HEAVY LIQUID: Am. Mineralogist, v. 45, no. 5/6, p. 726-728, table, May-June 1960, 5 refs.

The vapor pressure of dimethyl sulfoxide, $(CH_2)_3SO$, (sp. gr. = 1.10) is much closer to that of methylene iodide than either acetone or ethyl alcohol and it is recommended as a diluent for heavy liquid preparation. Dimethyl sulfoxide is miscible in acetone and water. Thus, methylene iodide can be recovered from acetone washings by mixing with water in the conventional manner. To hinder the decomposition and discoloration of the methylene iodide, the mixtures should be stored in contact with Cu wire.--D.O. Emerson.

2-2629. Griffitts, Wallace R., and A.P. Marranzino. FULLER'S EARTH AS AN AGENT FOR PURIFYING HEAVY ORGANIC LIQUIDS: Am. Mineralogist, v. 45, no. 5/6, p. 739-741, table, May-June 1960.

The metal content, dark color, and dissolved water of bromoform, diiodomethane, and acetylene tetrabromide were effectively reduced by shaking a few grams of fuller's earth with about 125 ml. of the liquid in a separatory funnel and tapping off the clear liquid. Ion exchange resins reduced the metal content but not the dark color or water. Serious contamination of mineral separates, especially clay minerals, can be avoided by this cleaning technique.--D.O. Emerson.

2-2630. Rogers, John J.W. MEASUREMENT OF REFRACTIVE INDICES IN THIN SECTION: Am. Mineralogist, v. 45, no. 5/6, p. 741, May-June 1960.

Xylene is used to dissolve the Canada balsam around the edges of the thin section. Just as it reaches the edge of the rock (about 15 min.), it is rinsed out with acetone. The index oil is inserted under the edge of the cover glass and after the determination it is washed out with acetone. If the mounting cement is not easily soluble in xylene, the rock edge should be "shaved" before the cover glass is attached with Canada balsam.--D.O. Emerson.

2-2631. Smith, Deane K. A SIMPLE CENTERING JIG AND GONIOMETER FOR PUNCHING OR DRILLING SPHERES FOR STRUCTURE MODELS: Am. Mineralogist, v. 45, no. 5/6, p. 717-725, 3 illus., 2 diags., May-June 1960, 9 refs.

Using a jig to hold the ball and center the drill, the first hole is drilled into a sphere. For all succeeding holes, a 3 circle goniometer guides the drill into the sphere at the desired bond angle from the index hole. The jig and goniometer are constructed from metal or cardboard with metal tube drill guides. Formulas are provided to convert atomic coordinates to bond angles. Bonding rods are cut with a modified electrician's crimping tool.--D.O. Emerson.

2-2632. Pistorius, Carl W.F.T. LATTICE CONSTANTS AND PROBABLE SPACE GROUP OF ANHYDROUS CUPRIC SULFATE (ARTIFICIAL CHALCOCYANITE): Am. Mineralogist, v. 45, no. 5/6, p. 744-746, table, May-June 1960, 2 refs.

Anhydrous cupric sulfate was prepared from $CuSO_4 \cdot 5H_2O$ by heating for 2 hours at 300°C. An X-ray powder pattern was indexed using the similarity to zinc sulfate. The orthorhombic unit-cell dimensions are: $a_o = 8.391 \pm .013$ Å, $b_o = 6.811 \pm .010$ Å, $c_o = 4.791 \pm .008$ Å. The axial ratio agrees with Palache, Berman, and Frondel, if their value is considered to be b:a:2c. Calculated density (25°C., Z = 4) is 3.873 and the space group was chosen as Pnma.--D.O. Emerson.

2-2633. Heinrich, E. Wm. STIBIOTANTALITE FROM THE BROWN DERBY No. 1 PEGMATITE, COLORADO: Am. Mineralogist, v. 45, no. 5/6, p. 728-731, 3 tables, May-June 1960, 17 refs.

Chemical, optical, physical, and X-ray data confirm an earlier report of the occurrence of stibiotantalite in the Brown Derby pegmatite, Colorado, and brings to 25 the number of minerals found there. Fragments up to 5 cm. long occurred in one area within an albite-quartz-lepidolite rock and were associated with pink tourmaline, quartz, and colorless muscovite (phengite?).--D.O. Emerson.

2-2634. Katz, Gerald. JACOBSITE FROM NEGEV, ISRAEL: Am. Mineralogist, v. 45, no. 5/6, p. 734-739, illus., 2 tables, May-June 1960, 15 refs.

This occurrence of jacobsite, the first recorded in the Middle East, is 26 mi. N. of Eilat, southern Negev, Israel. A large float boulder contained the mineral in association with hematite, limonite, goethite, and cross-cutting veinlets of psilomelane. From X-ray powder data 2 major phases, α-Fe_2O_3 and jacobsite were found along with minor amounts of goethite, α-$Fe_2O_3 \cdot H_2O$; a calcium manganese oxide hydrate (ASTM 4-0149); and in the nonmagnetic fraction, bementite. The jacobsite lattice constant of 8.51 + 0.001 Å suggests, from the data of Mason, a composition of 54 mol per cent Mn_3O_4 and 46 mol per cent Fe_3O_4. A discrepancy between the 8.51 Å lattice constant of synthetic manganese ferrite (33 mol per cent Mn_2O_3) and the 8.46 Å size from Mason's data is attributed to the Mn valence state or impurities.--D.O. Emerson.

2-2635. Lawrence, L.J. A CASSITERITE PSEUDOMORPH AFTER QUARTZ FROM TORRINGTON, NEW SOUTH WALES: Am. Mineralogist, v. 45, no. 5/6, p. 715-717, illus., May-June 1960, 2 refs.

Preexisting vein quartz was penetrated by cassiterite-bearing fluids in the Dutchman lode, Torrington Sn mining district, New South Wales. In most places the quartz was replaced by an aggregate of sericite, chlorite, and cassiterite but in one vug a 1 in. long crystal was completely replaced by fine-grained cassiterite.--D.O. Emerson.

2-2636. Schaller, Waldemar T., and Mary E. Mrose. THE NAMING OF THE HYDROUS MAGNESIUM BORATE MINERALS FROM BORON, CALIFORNIA - A PRELIMINARY NOTE: Am. Mineralogist, v. 45, no. 5/6, p. 732-734, table, May-June 1960, 13 refs.

Two hydrous magnesium borate minerals have recently been found in the sediments overlying the borax and kernite of the Open Pit, Boron, California. One, which was given the new name lesserite, is identical with the previously described inderite of western Kazakhstan, U.S.S.R. The other is kurnakovite which, like inderite, is a dimorph of $Mg_2B_6O_{11} \cdot 15H_2O$.--D.O. Emerson.

2-2637. Sokolov, G.A., and P.V. Komarov. ALTERATION OF LUDWIGITE IN THE MAGNETITE DEPOSIT OF ZHELEZNYY KRYAZH IN THE EASTERN TRANSBAIKAL REGION: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 8, p. 21-27, 7 illus., 3 tables, pub. May 1960.

English translation of GeoScience Abstracts 1-713.

2-2638. Vasileva, Z.V., and V.I. Kudryashova. [APATITE FROM THE TRAP FORMATION OF SIBERIA]: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 7, p. 92-96, 5 illus., table, pub. Apr. 1960, 5 refs.

English translation of GeoScience Abstracts 1-714.

2-2639. Chukhrov, F.V., V.A. Moleva, and L.P. Ermilova. NEW DATA ON MITRIDATITE: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 8, p. 12-20, 2 illus., 3 graphs, 5 tables, pub. May 1960, 9 refs.

Mitridatite is a calcium-iron phosphate in which the $(OH)_4$ group seems to replace one or another part of the (PO_4). The chemical formula of the mineral is: $Ca_2Fe_3 \cdot [(PO_4)_3(OH)_4] \cdot nH_2O$, where n is 2 on the average. The crystal system is monoclinic or triclinic. The aggregates are cryptocrystalline, earthy, porous, or massive. The color is tobacco-green to dark green. It dissolves in acids. The index of refraction is $\beta = 1.77$. Some of the particles are of colloidal size; such particles look like thin plates under an electron microscope.

Mitridatite is an alteration product of oxykerchenite (Ca-rich) or of anapaite (with loss of Ca); mitridatite can possibly be formed also as a result of a direct precipitation from solution. Mitridatite may be considered a metacolloid containing varying amounts of colloidal particles.--Auth. concl.

2-2640. Chao, Edward C.T., Eugene M. Shoemaker, and B.M. Madsen. FIRST NATURAL OCCURRENCE OF COESITE: Science, v. 132, no. 3421, p. 220-222, 4 illus., July 22, 1960, 8 refs.

Coesite, the high-pressure polymorph of SiO_2, hitherto known only as a synthetic compound, is identified as an abundant mineral in sheared Coconino sandstone at Meteor Crater, Arizona. This natural occurrence has important bearing on the recognition of meteorite impact craters in quartz-bearing geologic formations.--Auth.

2-2641. Mookherjee, Asoke, and K.C. Sahu. MICROHARDNESS OF THE PLAGIOCLASE SERIES: Am. Mineralogist, v. 45, no. 5/6, p. 742-744, diag., table, May-June 1960, 3 tables.

Using a Leitz "Durimet" indentation microhardness tester, the maximum Vicker's microhardness of 6 plagioclase crystals (from An_5 to An_{85}) was determined at working loads from 15 to 500 grams. The hardness appears to be a linear function of An content with a sharp break in the region of immiscibility (An_{30} to An_{70}). It is suggested that the deviation from rectilinearity might be a measure of 1) degree of exsolution or 2) degree of departure from original structure. Thus, microhardness studies might be used to detect structural breaks and compositional variation.--D.O. Emerson.

2-2642. Levinson, Alfred A., and R.A. Borup. NEW DATA ON THE HAFNIUM, ZIRCONIUM AND YTTRIUM CONTENT OF THORTVEITITE: Am. Mineralogist, v. 45, no. 5/6, p. 712-715, table, May-June 1960, 11 refs.

Two samples of thortveitite from Iveland, Norway and one from Befanamo, Madagascar were found by X-ray fluorescence to contain 0.6, 1.7, and 1.4 weight per cent HfO_2; 1.2, 1.9, and 1.4% ZrO_2; and 2.2, 4.4, and 4.3% Y_2O_3 respectively. The Hf/Zr ratio is almost twice as high in the thortveitite as in the earlier high Hf zircons it encloses. The validity of the high zirconia variety befanamite is questioned.--D.O. Emerson.

2-2643. Comer, Joseph J. ELECTRON MICROSCOPE STUDIES OF MULLITE DEVELOPMENT IN FIELD KAOLINITES: Am. Ceramic Soc., Jour., v. 43, no. 7, p. 378-384, 20 illus., diag., July 1960, 12 refs.

Preshadowed carbon replicas were used to follow changes in surface texture of poorly crystallized and well-crystallized kaolinites after firing to various temperatures between 850° and 1,200°C. X-ray diffraction was used for phase identification. Mullite was observed consistently in preferred orientation on the large well-crystallized kaolinite stacks but not on poorly crystallized specimens. Failure to detect mullite in preferred orientation in the latter may be due to flow of the reaction products which occurs in these specimens at temperatures below that at which mullite can be detected by electron microscopy or X-ray diffraction.--Auth.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Structural Geology 2-2512; Stratigraphy 2-2535.

2-2644. Chayes, Felix. OCCURRENCE OF NORMATIVE SODIUM METASILICATE IN WASHINGTON'S TABLES: Geol. Soc. America, Bull., v. 71, no. 4, p. 503-504, Apr. 1960, 5 refs.

Tuttle and Bowen have concluded that excess alkalis over alumina in magmatic residues would favor the gradual passage from granitic magma to hydrothermal solution. They cite the incidence of normative acmite (ac) and sodium metasilicate (ns) in Washington's tables (1917) as evidence that "granitic liquids contain alkalis in excess of that required to combine with all the alumina to form feldspars." According to tally, ns and ac are about as common in the

norms of subsilicic and femic rocks as in those of granitic rocks. In addition, the ratio of ns-bearing to ns-free norms in the tables is about 1:40, and on geological grounds it is reasonable to assume that this ratio is high by at least one order of magnitude. In almost 60% of the ns-bearing norms, the ns is less than 1%, and in more than a third it is less than 0.5%. Relatively small errors in the analytical partition of alkali could produce a few tenths of a percent of normative ns. The present writer feels that the proposed end-stage alkali-silicate enrichment in the normal course of granite crystallization must be sought elsewhere than in a table of rock analyses.--B.W. Pipkin.

2-2645. Tuttle, O. Frank. OCCURRENCE OF NORMATIVE SODIUM METASILICATE IN WASHINGTON'S TABLES: A REPLY: Geol. Soc. America, Bull., v. 71, no. 4, p. 505, Apr. 1960, 5 refs.

Bowen and Tuttle pointed out that phase-equilibrium considerations demonstrate that crystallization of alumina-undersaturated granitic liquids will produce residual liquids which exhibit a continuous gradation from hydrous silicate liquid to hydrothermal solution. Chayes [see above] objects to the evidence cited to support their contention that many rocks contain a slight excess of alkalies. He suggests that ns and ac in the norms from Washington's tables may represent nothing more than analytical errors. The author ventures to suggest that it is a remarkable analytical error that is committed 3 times more often when analyzing extrusive rocks than when analyzing plutonic rocks. Chayes contents that the alumina-undersaturated rocks are rare alkaline rocks. The author agrees that nepheline-bearing rocks are rare, but to class the hypersolvus granites which carry alkali pyroxenes and amphiboles with these alkaline rocks is not justified. A cursory glance at the phase diagrams for the systems Na_2O-Al_2O_3-SiO_2 and K_2O-Al_2O_3-SiO_2 will convince the reader that the alkaline nature of the granites is a result of alumina undersaturation, whereas the alkaline nature of the true alkaline rocks is a result of silica impoverishment. A granite or a nepheline syenite can be alumina-undersaturated, and, in either case, the alumina undersaturation may, on crystallization, result in the development of hydrous liquids which will have a continuous solubility relation with water. --B.W. Pipkin.

2-2646. Smith, Robert L. ASH FLOWS: Geol. Soc. America, Bull., v. 71, no. 6, p. 795-841, 3 illus., 2 charts, 4 diags., June 1960, 128 refs.; abs. in English, French, German, and Russian.

The ash flow is the basic unit of most pyroclastic deposits known as welded tuffs, tuff flows, pumice flows, or ignimbrites. Other useful units are the cooling unit, both simple and compound, the composite sheet, and the ash-flow field. The deposit of one ash flow is considered analogous to, but not necessarily the same as, the deposit produced by the passage of one nuée ardente. The geological evidence favors gas-emitting particulate flows as the agents of transport.

The ash-flow is an efficient heat-conserving mechanism, and, because many ash-flow fields contain cooling units believed to be derived from common magma, but clearly emplaced at different temperatures, a cooling mechanism must be invoked. Such a mechanism may be the vertical eruption column which influences the final properties of many ash flows.

Deposits are grouped in 7 orders of magnitude ranging from 0.001 to 10,000 km^3. Orders 1 to 3 include deposits erupted from domes. Those from craters rarely exceed 10 $km.^3$, order 4. Deposits of orders 5 to 7 are associated with subsidence structures in all examples where the source area is known. Welded tuffs occur in fields of all volumes, but they are common among the fissure-erupted deposits of larger volume. Some ash-flow fields distributed from a common source area reach areal dimensions of more than 12,000 sq. mi. and volumes of about 500 cu. mi.; some multiple-source fields are known to have volumes of more than 2,000 cu. mi. Deposits of single-eruption cycles having volumes of more than a few cubic miles are thought to be related to subsidence structures.

Sorting data suggest that most welded tuffs contain more than 70% by weight of materials less than 4 mm. in diameter. Welding and crystallization depend largely on relative temperature and thickness of the cooling units, and most of the textures in welded ash flows can be explained in terms of these variables. Welding begins with incipient cohesion of glass shards and fragments and continues with decreasing pore space and deformation to complete welding which results in a dense black glass.

Crystallization is superimposed on the welded material at any stage, but the degree of welding may influence the type of crystallization. The degrees of welding and of crystallization are zonal and permit the distinction between simple and compound cooling. Incipient welding may take place below 535°C., but complete welding depends on load pressure and time and is thus influenced by the cooling history of individual cooling units. Deposits emplaced at low temperatures such as the Crater Lake, Oregon, "pumice flows" are essentially nonwelded in thick deposits. The high-temperature welded tuffs of southeastern Idaho are densely welded in very thin sheets. Most welded tuffs are probably emplaced at temperatures intermediate between these limits. Some deposits record a systematic change in temperature during the eruption cycle; others record a change in magmatic composition. Some ash flows are thought to be genetically related to near-surface plutons, some of which are large and complex.--Auth.

2-2647. Fisher, Richard V. CLASSIFICATION OF VOLCANIC BRECCIAS: Geol. Soc. America, Bull., v. 71, no. 7, p. 973-981, July 1960, 99 refs.

Volcanic breccias are grouped into 3 major categories based upon process of fragmentation: autoclastic, pyroclastic, and epiclastic. Autoclastic volcanic breccias result from internal processes acting during movement of semisolid or solid lava; they include flow breccia and intrusion breccia. Pyroclastic breccia is produced by volcanic explosion and includes vulcanian breccia, pyroclastic flow breccia, and hydrovolcanic breccia. Epiclastic volcanic breccias result from transportation of loose volcanic material by epigene geomorphic agents, or by gravity, and include laharic breccia, water-laid volcanic breccia, and volcanic talus breccia. Other volcanic breccia terms are discussed.

The rock types mentioned heretofore may also be designated by prefixing compositional terms as in basaltic block breccia and andesitic vulcanian breccia. The term volcanic breccia is used as a general term applying to all coarse-grained rocks composed of angular volcanic fragments.--Auth.

2-2648. Gonshakova, V.I. DISTRIBUTION AND MECHANISM OF INTRUSTION [SIC] OF TRAP ROCKS

IN THE SOUTHEASTERN SIBERIAN PLATFORM: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 8, p. 28-41, 3 illus., 2 maps, 3 secs., 2 diags., 2 tables, pub. May 1960, 17 refs.

The southeastern part of the Siberian platform consists of 5 principal structural elements: 1) lower Paleozoic structural basin of the Angara-Lena region; 2) southwestern part of the Vilyuy basin; 3) northeastern end of the Baikal foldzone; 4) Berezov structural basin; 5) northern slope of the Aldan upwarp.

Local structures in the area controlled the intrusion of dikes and sills; the mechanism of trap intrusion exhibited distinctive characteristics in each of the structural elements. Normal trap rocks predominate, but palagonitic dolerite forms a special province in the Vilyuy depression. The mechanism of trap intrusion cannot be interpreted by a single theory but depends on the character of local magmatic activity and geologic make-up of the region. The principal factors are tectonic features of the upper and part of the lower structural levels, and the mobility of the trap magma which determines whether the trap displaces or assimilates the country rock.--M. Russell.

2-2649. Belov, I.V. FACIES AND CHEMICAL COMPOSITION OF THE TRACHY-BASALTS OF THE SAYAN-BAIKAL HIGHLANDS: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 7, p. 80-91, 2 diags., 6 tables, pub. Apr. 1960, 25 refs.

English translation of GeoScience Abstracts 1-722.

2-2650. Choquette, Philip W. PETROLOGY AND STRUCTURE OF THE COCKEYSVILLE FORMATION (PRE-SILURIAN) NEAR BALTIMORE, MARYLAND: Geol. Soc. America, Bull., v. 71, no. 7, p. 1027-1052, 8 illus., 3 maps (1 fold.), sec., 7 diags., 4 tables, July 1960, 35 refs.

The Cockeysville formation near Baltimore, Maryland, is a sequence of intricately folded carbonate-rich metasedimentary rocks about 750 ft. thick and of pre-Silurian age. The formation lies near the base of the Glenarm series, which mantles 5 elongated domes of Precambrian(?) basement gneiss at the eastern edge of the Piedmont province. Sediments and gneissose phases of the domes were regionally metamorphosed to about the amphibolite facies as defined by Eskola et al.

Crystalline metadolomite, calc-schist, and calcite marble constitute most of the Cockeysville. Local breakdown of dolomite accompanied the formation of diopside-quartz-tremolite calc-silicate marble and was marked by a "retrograde" paragenetic sequence of diopside to tremolite to talc.

Calcite marble, which occurs in distinct layers and discordant masses associated with calc-schist and phlogopite-calcite metadolomite, is believed to have had a multiple origin. Mineral assemblages and rock associations suggest that some of the marble formed syntectonically from argillaceous limestone, quartzose limestone, and argillaceous dolomite (dedolomitization); other calcite marble may have recrystallized from essentially pure limestone. Discordant masses of calcite marble formed in part by replacement of dolomite or argillaceous limestone and locally dilated their enclosing rocks; some of these masses may have begun crystallizing from limestone; all show coarse nondirectional fabric suggestive of a late tectonic or post-tectonic origin.

Metasomatism in the recrystallizing sediments was evidently restricted to aureoles around basic and granitic dikes. Such intrusions are rare, and in general the marbles are chemically similar to sedimentary carbonate rocks. Tourmaline, apatite, and scapolite, which are minor but widespread, can reasonably be attributed to recrystallization with little or no addition of material.

Metamorphic grade remains essentially constant throughout the area mapped by the writer. Various facies of the Cockeysville marble, however, can be assigned on the basis of their mineral assemblages to any one of several metamorphic subfacies; local variations of CO_2 pressure, H_2O pressure, and bulk composition may be largely responsible for these variations.

Structural elements in the carbonate rocks - minor fold axes, lineations, cross-joints, and foliation - closely reflect corresponding structural elements of the gneiss domes, and this parallelism diminishes with distance from the domes. The minor folds show a crude variation in intensity and type with distance from the domes.--Auth.

2-2651. Solovev, S.P. MAIN FEATURES IN THE DEVELOPMENT IN TIME OF METAMORPHIC ROCKS IN THE U.S.S.R. Translated by E.A. Alexandrov and Assoc.; Internat. Geology Rev., v. 2, no. 6, p. 476-488, 2 tables, June 1960.

Intensive geological and petrological study of the U.S.S.R., especially notable after 1945, has supplied an enormous amount of new published data on various metamorphic rocks. Analyses (including those of the present writer) of abundant materials collected from various petrographic regions permit a general sketch (in first approximation) to be made of the principal particulars of distribution in time (geological eras) for metamorphic and metasomatic rock types that differ in chemical composition and in conditions of formation.

It is necessary to indicate that elucidation of the main features of development of different metamorphic-rock types during definite intervals of geological time is not only of theoretical interest, but is of practical importance, in that different ore and mineral deposits are associated with metamorphic-rock zones.

In this paper, metamorphic rocks of various types, which formed during different periods of time are considered briefly. Primarily considered are rocks that formed under regional conditions (dynamothermal metamorphism), and rocks of different age that formed as a result of contact-metasomatic and other metasomatic processes. The latter part of the paper discusses particulars of metamorphic rock development during different geological eras (Archean, Proterozoic, Paleozoic, Mesozoic, and Cenozoic). Genetic relationship is examined between various metamorphic and metasomatic formations with magmatic bodies that differ in composition and depth of formation. Finally, an attempt is made to establish some probable causes of irregularities of metamorphic rock development in the earth's crust.--Auth.

2-2652. Tikhomirov, V.V. THE DEVELOPMENT OF THE EARTH'S CRUST AND THE NATURE OF GRANITE: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 8, p. 1-11, pub. May 1960, 30 refs.

English translation of GeoScience Abstracts 1-718.

2-2653. Kurshakova, L.D. ALTERATION OF WALL ROCK SPILITE AT THE BURIBAY CHALCO-

PYRITE DEPOSIT IN THE SOUTHERN URALS: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 8, p. 42-48, 3 illus., 3 diags., 2 tables, pub. May 1960, 5 refs.

English translation of GeoScience Abstracts 1-719.

10. SEDIMENTARY PETROLOGY

See also: Geomorphology 2-2488; Engineering Geology 2-2763, 2-2764.

2-2654. Brochu, Michel. NOUVEL INDICE D'EMOUSSE DES SÉDIMENTS MEUBLES [NEW ROUNDING INDEX FOR UNCONSOLIDATED SEDIMENTS]: Rev. Can. Géographie, v. 13, no. 3/4, p. 143-145, chart, July-Dec. 1959, 2 refs.; text in French, abs. in French and English.

The proposed rounding index is the application to sedimentary material of all dimensions of the index worked out by J. Tricart and M. Brochu in 1955 for the study of sands. This index characterizes each examined fragment of a sample by a single measure with the naked eye, according to the 5 following criteria: NU (non usé, or angular grains), SA (subarrondi, or sub-rounded), AR (arrondi, or rounded), OV (ovoïde, or ovoid) and R (rond, or rounded). This index has the fundamental advantage of permitting morphoscopical analysis of various detrital formations, from sand to boulder size including the intermediate dimensions, then facilitating, between the various dimensions of sediments, more rigorous comparisons which up until now have not been entirely possible, due to the differences between the method of analysis of the sands, and that of the analysis of fragments of superior dimension. This new rounding index constitutes a useful complement to the one defined by A. Cailleux which retains all its usefulness in laboratory or for certain very detailed studies.--Auth.

2-2655. Holland, C.H. LOAD-CAST TERMINOLOGY AND ORIGIN OF CONVOLUTE BEDDING: SOME COMMENTS: Geol. Soc. America, Bull., v. 71, no. 5, p. 633, May 1960, 5 refs.

Sullwold objects to the use of the term "load cast" and proposes to replace it by 3 new terms: "load pocket," "load wave," and "load fold" [GeoScience Abstracts 1-2565]. The present writer believes that the term "load cast," as it is presently used, is a satisfactory term and finds no valid reason for its replacement. With respect to convolute bedding, it is true that "load folds" might resemble such bedding if all the overlying coarser material were removed by erosion. But this is far from saying that the folds might be convolute bedding as suggested by Sullwold. One of the features of convolute bedding is that the convolutions die out not only downward but frequently upward as well. Whatever the origin of convolute bedding, it is not possible that "load folds" of the kind described could ever die out upward in this way. --B.W. Pipkin.

2-2656. Sullwold, Harold H., Jr. LOAD-CAST TERMINOLOGY AND ORIGIN OF CONVOLUTE BEDDING: FURTHER COMMENTS: Geol. Soc. America, Bull., v. 71, no. 5, p. 635-636, diag., May 1960, 5 refs.

The comments by Holland [see above] on the author's earlier paper call for a reply. Load pocket is not meant to replace load cast but to supplement it. The author conceives of load casting as the configuration of the under-surface of the turbidite (seen also as a wavy line in cross section), whereas the load pocket is the material within the load cast (seen only in cross section). These are 2 distinct concepts each requiring identity. Other concepts include the load mold, load fold, and the load wave. A reasonably consistent descriptive classification of 5 genetically related features results. Holland's comments on convolute bedding are well taken. It is true that folds that die out upward could not be load folds. However, the present writer has rarely seen them die out upward, and both illustrations of the feature in the paper which defined the term appear to show erosion at the top. If the term convolute bedding is descriptive, referring to internal contortions which may be distinguished from slump structures, but whose origin is not certain, then some beveled load folds may be convolute bedding. The writer prefers this concept. --B.W. Pipkin.

2-2657. Frye, John C., H.B. Willman, and Herbert D. Glass. GUMBOTIL, ACCRETION-GLEY, AND THE WEATHERING PROFILE: Illinois, State Geol. Survey, Circ. 295, 39 p., 5 figs., 5 tables, 1960, 17 refs.

Mineralogical studies have been made of the weathering profiles of the glacial till plains of Illinois. A comparison is made between profiles developed in situ and those that include accretion-gley.

In the upper part of the in situ profiles there is a significant depletion of the Na-Ca feldspars and garnet and appreciable depletion of ferromagnesian minerals. K-feldspar, tourmaline, zircon, and epidote show no measurable effect of weathering. Of the clay minerals in the till, the chlorite and biotite-type micas alter successively to vermiculite-chlorite, vermiculite, mixed-lattice clay minerals, and expandable vermiculite. Muscovite is more resistant.

Compared with the in situ profiles, the accretion-gleys show less mineral decomposition and possess a mixture of clay minerals ranging from chlorite to montmorillonite that indicates physical mixing rather than alteration in place. The total weathering effect in all materials studied is strikingly less than that attributed to gumbotil.

It is concluded that the term "gumbotil" has not been sufficiently restricted to render it a useful scientific term. Deposits of accretion-gley can be differentiated from in situ weathering profiles in the field, and such profiles should be described in terms of defined zones.--Auth.

2-2658. Middleton, Gerard V. CHEMICAL COMPOSITION OF SANDSTONES: Geol. Soc. America, Bull., v. 71, no. 7, p. 1011-1026, 4 diags., 5 graphs, 3 tables, July 1960, 47 refs.

The author has collected 168 chemical analyses from the literature. All analyses with less than 5% Al_2O_3 ("quartzite" clan) were removed. The remaining analyses were divided on a tectonic basis into 3 clans; taphrogeosynclinal, eugeosynclinal, and others (mainly exogeosynclinal). Histograms for the 7 major oxides and variation diagrams for K_2O/Na_2O and alkalies/Al_2O_3 indicate that the tectonic associations

group together clans of chemical analyses which differ significantly from each other. The eugeosynclinal graywackes especially differ from other sandstones by their low K_2O/Na_2O ratio, which is correlated with the presence of basic volcanic detritus. Arithmetic and geometric means for the 7 major oxides for the 4 clans are given.--Auth.

2-2659. Byrne, John V., and K.O. Emery. SEDIMENTS OF THE GULF OF CALIFORNIA: Geol. Soc. America, Bull., v. 71, no. 7, p. 983-1010, 4 illus., 14 figs. incl. maps, secs., diags., 3 tables, July 1960, 61 refs.

The Gulf of California is an elongate trough bordered by highlands on the W. and mostly by lowlands on the E. Fault scarps divide its floor into a succession of closed basins separated by ridges, some of which are capped by islands. Water flows into the open sea along the E. side and leaves along the W. side after partial evaporation. About half of the runoff from land reaching the gulf enters at its head via the Colorado River, but dilution of the gulf water is not evident. Winter upwelling caused by northwesterly winds brings high-nutrient (including high-silica) water to the surface where diatoms and other phytoplankton flourish so abundantly that they discolor the water. On death, the siliceous frustules fall to the bottom forming diatomaceous muds in the middle third of the gulf. High-organic matter in the muds is also a result of high production in surface waters and of anaerobic conditions within the sediments, although not in the water above them. Sediments of the northern third of the gulf are deltaic, and those of the southern third are normal marine green muds. Sands and gravels composed of shell debris and detritus from land are concentrated along the shores and in channels between islands where tidal currents are swift. The physiography and geological history indicate that the gulf is a taphrogeosyncline. Its sediments should form chiefly shale and graywacke, facies considered typical of geosynclines, although climatic and oceanographic factors may be more responsible for their deposition than are tectonic factors.--Auth.

2-2660. Hubert, John F. PETROLOGY OF THE FOUNTAIN AND LYONS FORMATIONS, FRONT RANGE, COLORADO: Colorado School Mines, Quart., v. 55, no. 1, 242 p., 43 illus., 2 maps, 2 charts, 5 secs., 16 diags., 5 graphs, 40 tables, Jan. 1960, 121 refs.

The report interprets the sedimentary history of the Permo-Pennsylvanian Fountain and Permian Lyons formations based on the stratigraphy, lithology, and petrography of these rocks along the Colorado Front Range from Eldorado Springs to Colorado Springs. Early tectonic quiescence produced first cycle orthoquartzites, black shales, thin coals, deltaic arkoses, and minor marine limestones in the basal Glen Eyrie shale member of the Fountain formation in the Manitou embayment. Later powerful uplift of the ancestral Front Range highland sharpened the relief so that the Fountain streams flowed eastward, concomitantly eroding fresh arkosic detritus and continually developing lateritic red soils. The climate was warm and seasonally humid during the Fountain time both in the highland and on the Fountain piedmont and alluvial fans.

The ancestral Front Range highland was an integrated tectonic unit which underwent continuous, but declining uplift during Fountain-Lyons-Lykins sedimentation. During Fountain deposition, the eastern margi of the ancestral highland was not far W. of the present Laramide foothills belt. The gravels in the lowest fifth of the Fountain arkose are consistently coarser than those in the second fifth, which in turn are coarser than the gravels in the upper three-fifth Furthermore, the ratio of channel arkose: flood-plai micaceous arkose: deltaic-lacustrine quartzose arkose rock types in the Fountain arkose consistently changes upward from approximately 71:29:0 to 85:7:8. The area adjacent to the Manitou embayment was a subunit of the highland, because the embayment contains the coarsest Fountain gravels and the thickest section of Fountain arkose (4,500 ft.). Current regimen and relative ease of exit for the finer grained, clayey detritus in the loci of deposition in the Fountain fluvial and Lyons shoreline systems produced characteristic field structures, mineralogy, texture, and heav mineral assemblages in the Fountain and Lyons rock types.

Between Eldorado Springs and Colorado Springs, the Fountain arkose, excluding the Glen Eyrie shale, averages 80% stream channel conglomerates and sandstones, 17% flood-plain clayey siltstones and shales, and 3% deltaic-lacustrine clayey sandstones and siltstones. The ratio among the grains (detrital particles larger than 0.03 mm. in size) of quartz plus chert plus metaquartzite rock fragments: feldspar plus granitic rock fragments: mica plus micaceous rock fragments is - in the channel arkoses, 44:53:3, in the flood-plain micaceous arkoses, 41:43:16, and in the deltaic-lacustrine quartzose arkoses, 72:24:4. The channel arkoses are coarser grained, with less kaolinitic-hematitic clayey matrix (9%) - i.e., detritus finer than 0.03 mm. - than the interbedded flood-plain micaceous arkoses (35% matrix). The channel arkose nonopaque heavy minerals are dominated by zircon (68%) with minor rutile, tourmaline, epidote, sphene, hornblende, garnet, staurolite, and local apatite and clinozoisite concentrations.

The largely littoral Lyons sandstone between Eldorado Springs and Colorado Springs averages 75% feldspathic quartzite sandstones, 24% arkose conglomerates and sandstones, and 1% micaceous siltstone and shale lenses. The predominance of coarse arkoses and feldspathic quartzite sandstones over lagoonal siltstones and shales suggests deposition along a submergent rocky coastline, rather than an emergent, sandy coastline with barrier islands and extensive lagoonal sediments. During Lyons time, the climate was wet and humid in the highland, but evidently became drier towards eastern Colorado where extensive evaporites, carbonates, and red siltstones were deposited.

The feldspathic quartzites were modified from arkose detritus from the ancestral Front Range high land in beaches, dunes, and offshore bars along a transgressive shoreline. The arkoses are predominantly shoreline deposits (locally fluvial), with coars arkosic detritus mixed with finer feldspathic quartzi sand.

This study shows the volumetric importance of transitional feldspathic quartzites intermediate between an arkose and orthoquartzite composition. Although transitional feldspathic rocks have not been widely reported in the geologic column, a change fr fluvial Fountain to shoreline Lyons environments, acting on a continuous supply of arkosic detritus fro the ancestral Front Range highland, produced the Lyons feldspathic quartzites by processes analogous to the well known modification of micaceous graywacke detritus to quartzose graywacke and micaceo

quartzite. The average ratio among the grains of quartz plus chert plus metaquartzite: feldspar plus granitic rock fragments: mica plus micaceous rock fragments in the feldspathic quartzites is 88:12:traces, and in the arkoses 57:41:2; the weighted ratio for the Lyons sandstone is 81:18:1. The feldspathic quartzites average 12% kaolinitic-illitic clayey matrix, and 3% carbonate, silica, and K-feldspar cements. The feldspar grains are predominantly K-feldspar with only traces of sodic plagioclase.

The relatively rich nonopaque heavy mineral assemblage of the derived Lyons feldspathic quartzites, containing apatite, clinozoisite, garnet, and staurolite, contrasts with the ultrastable zircon, tourmaline, and rutile assemblages of the widespread Appalachian and mid-continent first and second cycle orthoquartzites. A "ZTR index," the combined percentage of zircon, tourmaline, and rutile among the nonopaque heavy minerals, is proposed as a measure of the degree of modification of nonopaque heavy mineral assemblages of quartzose sandstones. In the Lyons sandstone, the ZTR index increases as the proportions of quartz increase and feldspar decrease in the detrital fraction, and as the nonaggregate quartz grains become smaller and better sorted. The optimum regression equation, determined by multiple regression procedures, is ZTR = 9.32 + 0.938 X (S_y = 18.9), where X is the proportion of quartz in the detrital fraction.--Auth.

2-2661. Shipek, Carl J. PHOTOGRAPHIC STUDY OF SOME DEEP-SEA FLOOR ENVIRONMENTS IN THE EASTERN PACIFIC: Geol. Soc. America, Bull., v. 71, no. 7, p. 1067-1074, 9 illus. incl. 2 col., map, table, July 1960, 17 refs.

A number of ocean-floor environments in the eastern Pacific have been investigated with the U.S. Navy. Electronics Laboratory Deep-Sea Camera, Type III. Fourteen ocean stations were occupied from the R/V Baird which participated in the Scripps Institution of Oceanography Expedition "Downwind." Nine successful lowerings to depths in excess of 4,500 m. along a track between San Diego, California, and Valparaiso, Chile, yielded a number of photographs of scientific interest. Analysis of these photographs has revealed that: certain areas of the Pacific sea floor are covered with surface concentrations of Mn; biological, chemical, and physical forces are acting continuously to form, change, and disrupt the microrelief and character of deep pelagic sediments; and the camera has proven useful as a scientific tool to conduct rapid surveys of the sediment-water interface for information on the character and distribution of geological, biological, and chemical phenomena.

The rate of accumulation of pelagic sediments is closely related to the chemical formation of Mn nodules to account for the existence of widely distributed and exposed quantities of such free minerals on the sea floor.--Auth.

11. GEOHYDROLOGY

See also: Geomorphology 2-2490.

2-2662. Leopold, Luna B., and Walter B. Langbein. A PRIMER ON WATER: 50 p., 16 figs. incl. illus., maps, diags., graphs, Washington, D.C., U.S. Geological Survey, 1960.

This primer was written to help meet an increasing need for general information about water and its use and control. The primer is in 2 parts. The first part tells about hydrology, or the science that concerns the relation of water to the earth, and the second part describes the development of water supplies and the use of water.--U.S. Geol. Survey.

2-2663. Baker, John A. WETLAND AND WATER SUPPLY: U.S. Geol. Survey, Circ. 431, 3 p., 1960.

From the standpoint of hydrology there are 4 types of wetland: 1) fresh-water swamps in which the swamp deposits are underlain by glacial till or bedrock; 2) fresh-water swamps in which the swamp deposits are underlain by marine or lacustrine clay and silt; 3) fresh-water swamps in which the swamp deposits are underlain by glacial outwash or alluvium consisting mostly of sand or sand and gravel; and 4) salt marshes and salt meadows. The Ipswich River basin, South Middleton, Massachusetts, is described to illustrate that swamp deposits and surfaces have an important role in the operation of certain water systems. They store water during periods of high precipitation and serve as discharge areas for much of the year, but occasionally they serve as recharge areas. When swamp surfaces are dry the moisture conditions in the swamp soils affect the infiltration rate directly and the rate of direct runoff indirectly. There are several aspects of swamp environment on which more information is needed with respect to the role of wetlands in water supply.--M. Russell.

2-2664. Nelson, R. William. IN-PLACE MEASUREMENT OF PERMEABILITY IN HETEROGENEOUS MEDIA. 1. THEORY OF A PROPOSED METHOD: Jour. Geophys. Research, v. 65, no. 6, p. 1753-1758, June 1960, 15 refs.

A method for in-place measurement of permeability in heterogeneous, saturated soils is presented. The method is based upon a general theory presented in 3 dimensions for saturated flow in a heterogeneous medium. When the permeability is considered to be the dependent variable, a first-order quasi-linear partial differential equation requires solution. It can be solved through an extension of Lagrange's method, in which a system of subsidiary differential equations is used. Through consideration of the identity of 2 of the Lagrange subsidiary equations with the 3-dimensional stream function, a special interrelationship is shown.

The interrelationship between the method of analytical solution and the stream function has special significance with respect to the boundary condition. If the arbitrary or boundary function satisfies part of the subsidiary differential equations, no unique solution exists. In the physical problem this requirement for uniqueness indicates that the permeability measurements used for a boundary condition cannot be measured along a stream tube.--Auth.

2-2665. Meyer, Adolph F. EFFECT OF TEMPERATURE ON GROUND-WATER LEVELS: Jour. Geophys. Research, v. 65, no. 6, p. 1747-1752, map, 5 graphs, 2 tables, June 1960, 3 refs.

The results of both laboratory experiments and field investigations in Minnesota and Nebraska are presented to show that ground-water levels fall from 1 to 2 ft. during the winter, with reduction in air temperature, and rise approximately the same amount in spring with increased air temperature. This condition was found to prevail in different soils during periods when there was neither evapo-

transpiration nor deep seepage to account for the observed change in ground-water levels. In the areas studied both surface topography and ground-water topography showed very flat slopes. In fact, the water table was almost level.

The observations apply to areas of relatively shallow water table. Daily fluctuations of ground-water levels in Nebraska due to evapotranspiration and temperature are also graphed.--Auth.

2-2666. Haushild, William, and Gordon Kruse. UNSTEADY FLOW OF GROUND WATER INTO A SURFACE RESERVOIR: Am. Soc. Civil Engineers, Hydraulics Div., Jour., v. 86, no. HY7, p. 13-20, 3 diags., table, July 1960, 6 refs.

Prediction of the water table position and the amount of water discharged where ground water is flowing from an aquifer to a surface reservoir has not been exact. The nonlinear partial differential equation that describes the shape of the water table is difficult to solve.

Approximate solutions obtained by 2 different methods for the nonlinear equation are presented. Both approximate solutions agree better with experimental results than does the exact solution of the simplified linear equation for the flow.--Auth.

2-2667. Kohout, F.A. CYCLIC FLOW OF SALT WATER IN THE BISCAYNE AQUIFER OF SOUTHEASTERN FLORIDA: Jour. Geophys. Research, v. 65, no. 7, p. 2133-2141, map, 6 secs., diag., 2 graphs, July 1960, 10 refs.

Observations over a period of nearly 20 years confirm the fact that the salt-water front in the Biscayne aquifer along the coast of the Miami area, Florida, is dynamically stable at a position seaward of that computed according to the Ghyben-Herzberg principle. During periods of heavy recharge the fresh-water head is high enough to cause the fresh water, the salt water, and the zone of diffusion between them to move seaward. In addition to this bodily movement of the system, there is a seaward flow of diluted salt water in the zone of diffusion. When the fresh-water head is low, salt water in the lower part of the aquifer intrudes inland, but some of the diluted sea water in the zone of diffusion continues to flow seaward. Cross sections showing equipotential lines in terms of equivalent fresh-water head show that the sea water flows inland, becoming progressively diluted with fresh water, to a line along which there is no horizontal component of flow, after which it moves upward and returns to the sea. The cyclic flow acts as a deterrent to the encroachment of sea water because of return to the sea of a part of the inland flow.--Auth.

2-2668. Trainer, Frank W. GEOLOGY AND GROUND-WATER RESOURCES OF THE MATANUSKA VALLEY AGRICULTURAL AREA, ALASKA: U.S. Geol. Survey, Water-Supply Paper 1494, 116 p., 10 maps (2 in pocket incl. col. geol. map, scale 1 in. to 1 mi.), 2 diags., (1 in pocket), 2 graphs, 5 tables, 1960, 45 refs.

This report describes the geology and ground-water resources of an area of present and potential agricultural development in S.-central Alaska. The Matanuska Valley agricultural area, which covers about 350 sq.mi., is in a wide valley flanked by rugged mountains. The valley floor is underlain nearly everywhere by glacial drift whose total thickness is known at relatively few places. Bedrock is exposed or known to be near the surface in only a small part of the entire valley floor. Nonglacial unconsolidated deposits include windblown material distributed generally over the agricultural area and slope deposits along the valley walls.

The youngest drift, which is at the land surface throughout the area, is thought to be of late Wisconsin age. Exposures and well logs record at least 1 older drift sheet in several localities, and 2 older drifts are known to be present at one place in the agricultural area. These older deposits have no topographic expression in the valley floor.

The drift includes till, outwash stream deposits, and estuarine and lake(?) deposits. Physiographic features formed by these deposits in or adjacent to the agricultural area include an end moraine, lateral moraines, eskers, crevasse fillings and other pitted features, river terraces, outwash flood plains, and an extensive estuarine flat. Stagnation of the ice was an important phase of the deglaciation of this area. The topographic form of the valley floor is due chiefly to deposition by glacial ice and melt water, ice-block pitting, and terracing by melt-water streams.

The till, known locally as "hardpan," is characteristically silty or clayey, tough, and relatively impermeable. The youngest till, which is the best known, forms ground moraine in part of the area and a buried deposit in much of the remainder of it. From information obtained in the relatively small parts of the area where wells are closely spaced the till appears to be a single, more or less continuous, sheet. This till commonly ranges in thickness from about 10 to about 60 or 70 ft.; several wells penetrate till 100 ft. or more thick (in one well its thickness appears to exceed 400 ft., but it is thought that the thicker sections include 2 or more till units. The chief hydrologic significance of the till is that it forms a confining layer for artesian aquifers. The till is generally not water bearing except where it contains layers of sand or gravel, and these are commonly thin and yield only small quantities of water.

The outwash deposits are chiefly sand and sandy gravel. Boulder gravel is present in some places, especially in former drainage courses that were probably near the melting ice. The well-sorted materials are relatively permeable and transmit water readily. Outwash deposits of silty sand and poorly sorted silty gravel are much less permeable. Individual sandy and gravelly beds in the outwash deposits are commonly thin and interlayered. However, a number of wells have penetrated thick deposits of sand; much of this sand becomes unstable under the differences in hydrostatic head commonly produced during drilling or pumping and flows into the wells as "quicksand."

In much of the area, sheetlike outwash deposits just beneath the land surface range in thickness from a few feet to more than 100 ft. Ground water in these deposits is unconfined. In some places perched or semiperched ground water is present above till, bedrock, or layers of stream-laid silt.

Other outwash deposits are buried beneath till. They are known to be as much as 50 to 60 ft. thick and probably are considerably thicker in some places. They commonly contain confined (artesian) ground water. Well logs and hydrologic data suggest that buried outwash deposits form a continuous or almost continuous layer in an area of more than 10 sq.mi. near the community of Palmer. Similar buried deposits are known to be present in several other parts of the agricultural area also.

The area was overridden by 2 large valley glaciers that joined here to form a piedmont ice lobe. The repeated advance and recession of the ice, the effects of melt-water streams, and possibly the formation of temporary lakes contributed to the complex stratigraphy of the drift which makes prediction of the presence and character of aquifers difficult.

Ground water occurs in the mantle of windblown material (loess and sand) only under special conditions, but the mantle is important hydrologically because it absorbs precipitation readily. This absorption provides soil moisture, leads to ground-water recharge, and reduces direct runoff.

The bedrock, chiefly sandstone, shale, and greenstone of Cretaceous and Tertiary age, is not an important aquifer.

Most wells in the agricultural area tap sand and gravel of the outwash deposits, and household and farm wells tapping suitable material generally provide dependable supplies. Only a few larger capacity wells have been constructed. Two wells belonging to the city of Palmer have produced an average of about 100,000 gallons per day (g.p.d.) since late 1953, and water-level records suggest that equilibrium of recharge to and discharge from the aquifer has been attained near these wells for this rate of withdrawal. Data provided by test pumping 2 wells in other parts of the agricultural area suggest that properly constructed wells, penetrating a sufficient thickness of favorable water-bearing material, may produce as much as 100 to 200 or more gallons per minute. However, no information is available regarding the effect of irregularities of the drift stratigraphy near those wells on the maintenance of sustained yields over long periods. Except for the relatively heavy pumping of the 2 municipal wells, ground-water withdrawal in the agricultural area has been on such a small scale and so widely dispersed that it probably has had a negligible effect on ground-water levels.

In the development of ground-water supplies in this area, the chief problems that cannot be solved by improved well construction are thought to be due to the apparent absence of suitable water-bearing material in places where sand becomes "quick" during the drilling or where little or no permeable material is penetrated.

Replenishment of the ground water is chiefly from precipitation. However, probably only a small proportion of the annual precipitation, which averages about 15 in., reaches the ground-water body, and very dry seasons are accompanied or followed by a marked decline of water levels in some wells. In a few places water-table aquifers are recharged by water from streams. Natural discharge from the aquifers occurs by seepage and spring flow into streams and lakes, by evaporation, and by transpiration by plants.

The ground water is a moderately hard, calcium magnesium bicarbonate water generally suitable for domestic purposes. A few wells have obtained salty water or water that has objectionable hardness, Fe content, or other characteristics. The salt water is thought to have been trapped in the bedrock when marine or estuarine water lay over this part of the region.

The area is divided into 6 physiographic units to facilitate description of the occurrence of ground water. Data include records of 391 wells, whose locations are shown on the geologic map, the logs of 44 wells, and chemical analyses of 27 ground-water samples.--Auth.

2-2669. Page, Roland W., W.R. Moyle, Jr., and Lee C. Dutcher. DATA ON WELLS IN THE WEST PART OF THE MIDDLE MOJAVE VALLEY AREA, SAN BERNARDINO COUNTY, CALIFORNIA: California, Dept. Water Resources, Bull. 91-1, 126 p., geol. map (in pocket, scale 1:62,500), 7 tables, 1960, 15 refs.; also pub. as: U.S. Geol. Survey, Repts., Open-File Ser., 1959.

Data are given on approximately 625 wells canvassed within an area of 470 sq.mi. of the W. part of the middle Mojave Valley, San Bernardino County, as part of an investigation to collect and tabulate all available hydrologic data for the desert regions of southern California.

The scope of the work on which the report is based included: "1) visiting and examining most of the water wells in the area, determining and recording their locations in relation to geographic and cultural features and the public-land net, and recording well depths and sizes, types and capacities of pumping equipment, uses of the water, and other pertinent information; 2) measurements of the depth to the water surface below an established and described measuring point at or near the land surface; 3) selection of representative wells to be measured periodically in order to detect and record changes of water levels; and 4) collection and tabulation of well records, including well logs, water-level measurements, and chemical analyses."--M. Russell.

2-2670. Fishel, V.C., and Margaret E. Broeker. GROUND-WATER LEVELS IN OBSERVATION WELLS IN KANSAS, 1959: Kansas, State Geol. Survey, Bull. 146, 174 p., 16 maps, 9 graphs, 4 tables, 1960, 6 refs.

Measurements of water levels in 835 wells in 76 counties in Kansas in 1959 are given in this report, which is the fourth in a series of annual water-level reports to be published by the state. Records for part of the wells for years prior to 1956 have been published in an annual series of water-supply papers by the U.S. Geological Survey; records for some of the wells that are in the Missouri basin have been issued in an annual series of mimeographed reports for the years 1947 through 1955; and records for some wells have been included in both reports.

Annual precipitation ranged from 54.07 in. at Elgin in southeastern Kansas to 12.54 in. at Tribune in western Kansas. Most of the state received above normal precipitation for the year, but the precipitation was below normal in a few local areas.

During 1959 the ground-water levels in most wells in Kansas declined a small amount. The average decline of the water levels in 12 wells in western Kansas was about 1.0 ft. The average decline of the water level in 4 key wells in central Kansas was about 0.6 ft. The decline of the water level in a key well in eastern Kansas was about 2.0 ft. During the drought years 1952 through 1956, most ground-water levels in Kansas were at record low stages. The water level in many wells had recovered during 1957 and 1958 to the pre-drought stage.--Auth.

2-2671. Hodson, Warren G., and Kenneth D. Wahl. GEOLOGY AND GROUND-WATER RESOURCES OF GOVE COUNTY, KANSAS: Kansas, State Geol. Survey, Bull. 145, 126 p., 6 illus., 8 maps (2 in pocket), chart, 9 secs. (4 in pocket), 4 diags., 4 graphs, 11 tables, 1960, 39 refs.

This report describes the geography, geology, and ground-water resources of Gove County, in W.-central Kansas in the high plains physiographic section. The county has an area of approximately 1,070 sq.mi.

and had a population of about 4,200 in 1957.

The rocks that crop out in Gove County are sedimentary and range in age from Cretaceous to Recent. Chalk beds of the Fort Hays chalk member of the Niobrara chalk [Cretaceous] are the oldest rocks exposed in the county. They are overlain by the Smoky Hill chalk, upper member of the Niobrara chalk; the Smoky Hill crops out in much of the southern part of the county. It is overlain by the Pierre shale, of Late Cretaceous age, which is exposed in a faulted area in the southwestern part of the county but in the northwestern part is found only in the subsurface. Fluviatile deposits of the Ogallala formation, of Pliocene age, cover most of the northern part of Gove County. Unconsolidated continental deposits of fluviatile and eolian origin represent 4 stages of the Pleistocene epoch. Loess classified as Loveland and Peoria formations, of late Pleistocene age, mantles much of the interstream areas, particularly in the northern part of the county. Alluvium of Wisconsinan and Recent age fills the inner valleys of Smoky Hill River, Hackberry Creek, and Big Creek. Older alluvial deposits, of Illinoisan and Kansan age, dissected and in a high terrace position, occur along the larger streams in the county, chiefly along Smoky Hill River. The surface geology of Gove County is shown by a geologic map; cross sections illustrate the stratigraphic relations of the geologic formations.

Ground water is one of the principal natural resources of the county; most water supplies are obtained from wells. Moderate quantities of ground water are available from the Ogallala formation and from alluvial deposits in Hackberry Creek and Big Creek valleys. About 1.2 million acre-ft. of ground water is in storage in the Ogallala formation in the northern two-fifths of Gove County. In the southern part, ground water is almost restricted to alluvial valleys. Moderate to large quantities of water are available from alluvial deposits in the Smoky Hill River valley. Only meager quantities, derived mostly from colluvial materials, are available in the interstream areas in the southern part of the county. A few wells in the southeastern part obtain water from the deeper-lying Dakota formation [Lower Cretaceous].

The chemical quality of the ground water is closely related to geologic source, and distinctive types of water are characteristic of each water-bearing formation in the county. Ground water from the Ogallala formation is fair to good. Water from the alluvium is generally very hard but otherwise suitable for most purposes.

Ground-water pumped for domestic and stock use in Gove County is estimated to be about 800 acre-ft. per year. Approximately 500 acre-ft. is pumped annually by municipal wells, and an estimated 6,000 acre-ft. for irrigation.

Ground-water in the Ogallala formation in the northern upland moves eastward down an average gradient of about 11 ft. per mi. The rate of movement was calculated to be about 0.3 ft. per day. The amount of ground water leaving the county underground is believed to be less than that entering the county; much of the difference is accounted for by seepage of ground water from the Ogallala formation at the contact of the Ogallala on Cretaceous bedrock along Hackberry Creek and Big Creek valleys.

The field data upon which this report is based are given in tables. They include records of 309 wells and test holes, logs of 83 wells and test holes, and chemical analyses of water from 52 representative wells, 4 municipal supplies, and 1 sample from Smoky Hill River.--Auth.

2-2672. Bayne, Charles K. GEOLOGY AND GROUND-WATER RESOURCES OF HARPER COUNTY, KANSAS: Kansas, State Geol. Survey, Bull. 143, 184 p., 8 maps (4 in pocket), chart, 2 secs. (1 in pocket), 3 diags., 8 graphs, 10 tables, 1960, 11 refs.

This report describes the geography, geology, and ground-water resources of Harper County in S.-central Kansas. The field data upon which this report is based are given in tables; they include records of 458 wells and test holes, chemical analyses of 32 water samples from wells and test holes, and 317 logs of wells and test holes.

The rocks that crop out in Harper County range in age from Paleozoic to Recent. The oldest of these are a part of the Ninnescah shale of Permian age. Younger Permian rocks that crop out are the Harper siltstone and the Salt Plain siltstone. The Permian rocks in Harper County yield small quantities of hard water. Pleistocene deposits, ranging in age from Nebraskan to Recent, unconformably overlie the Permian rocks in the valleys and over much of the upland. These deposits consist of silt, sand, and gravel, and yield moderate supplies of water in parts of the county.

The report contains a map showing the areas of outcrop of the rock formations. The shape and slope of the water table are shown by means of contours, the locations of wells and test holes for which records are given also are shown on maps.

The ground-water reservoir is recharged principally from rain and snow that falls within the county, by percolation from streams and depressions, and by underflow from adjacent areas. Ground water is discharged from the ground-water reservoir by seepage into streams, by transpiration and evaporation, by movement into adjacent areas, and by wells. Water is pumped from wells in Harper County for domestic, stock, municipal, industrial, and irrigation use. Yields as great as 500 g.p.m. can be obtained from wells located in the most productive areas. The results of aquifer tests are included in this report.

Chemical analyses of samples of water from Harper County indicate that the quality varies greatly from place to place. Strong concentrations of sulfate are common in water from the Permian rocks. Water from Pleistocene deposits, although fairly hard, generally is suitable for most uses.--From auth. abs.

2-2673. Lane, Charles W. GEOLOGY AND GROUND-WATER RESOURCES OF KINGMAN COUNTY, KANSAS: Kansas, State Geol. Survey, Bull. 144, 174 p., 7 maps (2 in pocket), 3 secs. (1 in pocket), 5 diags., graph, 7 tables, 1960, 34 refs.

Kingman County, which covers about 864 sq. mi. in the S.-central part of Kansas, lies in the high plains and red hills sections of the Great Plains physiographic province.

The rocks that crop out in the county are sedimentary and range in age from Permian to Recent. The Ninnescah shale of Permian age is the oldest rock cropping out in the county. Most of the county is underlain by unconsolidated deposits of silt, sand, and gravel of Pleistocene age, which were deposited by southeastward-flowing streams. Deposits of the 4 major stages of the Pleistocene are present in the county. A list of early Pleistocene fossil mollusks collected at 2 localities in the county is given.

Ground water is one of the most important natural resources of Kingman County. All domestic, municipal, industrial, and most stock and irrigation water

supplies in the county are derived from ground water. Withdrawal of ground water for all uses in the county is estimated to be about 5,600 acre-ft. per year. The principal aquifer in the county is the Holdrege formation of late Nebraskan age. The Grand Island formation of late Kansan age is capable of yielding large water supplies in the western part of the county and is utilized in that area. In the eastern part of the county, where Permian rocks are near the surface, small water supplies for stock and domestic use are generally available from the weathered zone in these rocks. The ground water in the county is moderately hard but satisfactory for most uses, except where water containing excessive sodium chloride infiltrates the aquifer from South Fork of Ninnescah River and where, in the extreme southeastern corner of the county, water from the Permian rocks contains much chloride and sulfate.

The ground-water reservoir in the county is recharged by precipitation within the county and by subsurface inflow along the western and northwestern borders of the county. The general direction of ground-water movement is eastward but toward the major streams. Ground water is discharged principally by evaporation and transpiration in the stream valleys and by seepage into the streams. Discharge by wells and subsurface outflow account for only a small part of the ground-water discharge.

The field data upon which this report is based include records of 79 wells, chemical analyses of water from 21 wells, 2 springs, and 2 rivers, and logs of 247 test holes, 7 wells, and 30 oil well tests.--From auth. abs.

2-2674. Meyers, Theodore R., and Edward Bradley. SUBURBAN AND RURAL WATER SUPPLIES IN SOUTHEASTERN NEW HAMPSHIRE: New Hampshire State Plan. & Devel. Comm., Mineral Resources Survey, Pt. XVIII, 26 p., 2 maps (1 in pocket), 7 diags., 1960, 8 refs.

This paper reviews basic principles of the occurrence of ground water, especially as related to private water supplies in southeastern New Hampshire. The surficial deposits of this area, for which the ground-water potential is evaluated, include modern beach deposits, alluvium, swamp deposits, later outwash and shore deposits, ice-contact deposits, and till.--M. Russell.

2-2675. Geraghty, James J. GROUND-WATER PROBLEMS IN THE NEW YORK CITY AREA: New York Acad. Sci., Annals, v. 80, art. 4, p. 1049-1059, 4 maps, 2 graphs, 1959, 6 refs.

Several of the more serious ground water conditions that have developed in the New York metropolitan area are discussed and others that may become troublesome in the future are outlined.

One of the most serious problems is the steady decline of ground-water levels in the vicinity of some heavily pumped installations. Excessive pumping has occurred at several localities within the city limits and in the densely populated suburban areas of New Jersey and Long Island.

Another problem of increasing concern is encroachment of salty water into underground water-bearing formations in shoreline areas. This type of contamination has occurred on Long Island, Manhattan Island, and Staten Island, and also at various localities in New Jersey that are adjacent to tidal inlets and marshes.

Other ground-water problems in the region have arisen from increases in ground-water temperatures, contamination and pollution by domestic and industrial wastes, and flooding of subsurface structures caused by pronounced recoveries of ground-water levels.--From auth. introd.

2-2676. Perlmutter, Nathaniel M., and Herbert C. Crandell. GEOLOGY AND GROUND-WATER SUPPLIES OF THE SOUTH-SHORE BEACHES OF LONG ISLAND, N.Y.: New York Acad. Sci., Annals, v. 80, art. 4, p. 1060-1076, map, 5 secs., 3 tables, 1959, 20 refs.

In 1957 an average of 7 million gallons per day (m.g.d.) of water was pumped from wells screened in Upper Cretaceous, Pleistocene, and Recent deposits beneath the south-shore beaches of Long Island. These deposits have a total thickness of about 500 to 1,900 ft. The Upper Cretaceous deposits consist of the Lloyd sand member of the Raritan formation, confined by the clay member of that formation, and of younger beds that include the Magothy formation. In part of Suffolk County the uppermost Cretaceous unit is a fossiliferous green sand tentatively correlated with the Navarro group of Texas. The Cretaceous aquifers contain fresh water in much of the area, but yield salty water in the extreme eastern and western parts. Two Pleistocene aquifers, separated by an interglacial clay, contain fresh water in some places and salty water in others. Recent deposits commonly contain salty water except for a thin lens of fresh water floating on salt water in the uppermost part.

The Recent and upper Pleistocene deposits are recharged by local precipitation. The deeper Pleistocene and Cretaceous artesian aquifers are recharged mainly by underflow from the middle of the island. The problem of sea-water encroachment should be considered in planning additional large developments. --Auth. summ.

2-2677. Swarzenski, Wolfgang V. GROUND-WATER SUPPLIES IN PLEISTOCENE AND CRETACEOUS DEPOSITS OF NORTHWESTERN NASSAU COUNTY, N.Y.: New York Acad. Sci., Annals, v. 80, art. 4, p. 1077-1091, 3 maps, 3 secs., 1959, 6 refs.

In cooperation with the Nassau County Dept. of Public Works and the New York State Water Power and Control Commission, the United States Geological Survey has completed the field work of a rather detailed investigation of geology and ground-water occurrence in northwestern Nassau County, New York. The area, approximately 63 sq.mi., includes the peninsulas called Great Neck and Manhasset Neck, the western part of Nassau County as far S. as Garden City, and a small area in northeastern Queens. Unconsolidated sediments of Pleistocene and Cretaceous age, 200 to 800 ft. in total thickness, constitute the ground-water reservoir of the area. Detailed study of well logs has revealed the presence of Pleistocene and pre-Pleistocene channels cut in the Cretaceous deposits and in bedrock beneath the Cretaceous. The locations and dimensions of the channels and the character of the subsequent Pleistocene fill markedly affect the pattern of ground-water circulation. The ground-water reservoir contains 3 discrete aquifers, not all found in the same area, which transect geologic boundaries. The shallow unconfined aquifer occurs essentially in upper Pleistocene deposits; the principal aquifer includes some of the older Pleistocene deposits, but consists principally of the Magothy(?) formation of Late Cretaceous age; and the deep confined aquifer is in the

Jameco gravel and the Lloyd sand member of the Raritan formation of Late Cretaceous age. During 1957 the total withdrawals of water for public supply amounted to 30 million gallons per day, of which 72% was pumped from the principal aquifer.--Auth. summ.

2-2678. Arnow, Theodore. GROUND-WATER GEOLOGY OF BEXAR COUNTY, TEXAS: Texas, Board Water Engineers, Bull. 5911, 52 p., 11 maps, 2 secs., diag., 6 graphs, 3 tables, Oct. 1959, 26 refs.

The investigation in Bexar County was part of a comprehensive study of a large area in S.-central Texas underlain by the Edwards and associated limestones of Cretaceous age. The limestones form an aquifer which supplies water to the city of San Antonio, several military installations, many industrial plants, and many irrigated farms. The investigation, started in 1932, is a cooperative project of the U.S. Geological Survey, the Texas Board of Water Engineers, and the San Antonio Water Board. The report includes a geologic map and 2 cross sections of the county, a description of the geologic formations, and a discussion of the major aquifer, the Edwards and associated limestones.

The geologic formations that yield water to wells in Bexar County are sedimentary rocks of Mesozoic and Cenozoic age. The rocks strike northeastward and dip southeastward toward the Gulf of Mexico. In the northern part of the county, in an erosional remnant of the Edwards Plateau, the rocks are nearly flat and free from faulting. In the central and southern parts of the county, however, the rocks dip gulfward at moderately steep angles and are extensively faulted in the Balcones and Mexia fault zones. Individual faults or shatter zones were traced as far as 25 mi.; the maximum displacement is at least 600 ft. In general, the formations are either monoclinal or slightly folded; in the western part of the county the broad Culebra anticline plunges toward the SW.

Most of the large-capacity wells in Bexar County draw water from the Edwards and associated limestones, but a few draw from the Glen Rose limestone, the Austin chalk, and surficial sand and gravel. The Hosston formation, Glen Rose limestone, Buda limestone, and Austin chalk, all of Cretaceous age, generally yield small to moderate supplies; the Wilcox group and Carrizo sand of Tertiary age and alluvium of Pleistocene and Recent age generally yield small supplies.

The Edwards and associated limestones are recharged primarily by ground-water underflow into Bexar County from the W., and secondarily by seepage from streams that cross the outcrop of the aquifer in Bexar County. During the period 1934-1947 the recharge to the aquifer in Bexar County is estimated to have averaged between 400,000 and 430,000 acre-ft. per year.

Discharge from the aquifer takes place by means of wells and springs and by underflow into Comal and Guadalupe counties on the NE. During the period 1934-1947 the estimated average discharge from wells and springs was about 174,000 acre-ft. per year. The discharge by underflow out of the county during the period is estimated to have averaged between 220,000 and 260,000 acre-ft. per year. The movement of water into Comal and Guadalupe counties is indicated by contours on the piezometric (pressure-head-indicating) surface of the Edwards and associated limestones in Bexar County for the years 1934, 1952, 1954, and 1957. Probably only a small amount of water moves downdip SE. of San Antonio. The presence of highly mineralized water in that area suggests that the circulation of water is poor because of the low permeability of the aquifer.

During the period 1934-1956 the discharge from the Edwards and associated limestones greatly exceeded the recharge; consequently, water levels in wells declined. The decline was greatest in the northwestern part of the county, where the water levels in wells dropped as much as 100 ft. The decline was progressively less toward the E., averaging 40 ft. along the Bexar-Comal County line. The area of the greatest concentration of discharge, including San Antonio and extending to the SW. and NE., which coincides with the area of maximum faulting and maximum recorded yields from wells, is not the area of greatest decline. The ability of the Edwards and associated limestones to transmit and store water in the San Antonio area apparently is so great that the discharge from wells results in much smaller declines of water level than do similar or even smaller discharges in other, less favorable areas.

The water from the Edwards is almost uniformly a calcium bicarbonate water of good quality, although hard. In the southern part of the San Antonio area the water is charged with hydrogen sulfide; farther downdip it becomes highly mineralized.--Auth.

2-2679. Larsen, Norbert W. GEOLOGY AND GROUND WATER RESOURCES OF NORTHERN CEDAR VALLEY, UTAH COUNTY, UTAH: Brigham Young Univ., Dept. Geology, Brigham Young Univ. Research Studies, Geology Ser., v. 7, no. 1, 42 p., 2 maps (1 fold.), chart, 3 fold. secs., 2 tables, Apr. 1960, 13 refs.

Northern Cedar Valley lies in the extreme NW. corner of Utah County between the Oquirrh Mountains to the W., Lake Mountain to the E., and the Traverse Range to the N. The valley is 13 mi. long and 8 mi. wide, and is one of the basins of interior drainage in the extreme eastern portion of the Basin and Range province. The maximum relief between the valley floor and the surrounding mountain tops is 5,795 ft. West Canyon in the Oquirrh Mountains has the only permanent stream flowing into the valley.

The climate is semiarid and temperate with an average precipitation of 10.44 in. per year on the valley floor. The Oquirrh Mountains receive 25 in. or more of precipitation per year. The valley supports about 300 residents, with agriculture as the major source of livelihood.

Sedimentary rocks of Paleozoic age supply most of the sediments which are shed into the valley. These rocks consist mainly of limestone, quartzite, and shale. The alluvial deposits in northern Cedar Valley are at least 1,258 ft. thick. The thickest sediments in the valley are the pre-Lake Bonneville deposits (Tertiary(?) and Pleistocene). These deposits are a series of interbedded fluviatile and lacustrine sediments. The Lake Bonneville group is represented in the valley by the Alpine and Bonneville formations.

The sedimentary conditions which have prevailed in the valley since the beginning of Lake Bonneville time are considerably different than those in the larger valleys that were occupied by the lake. The history of the lake in Cedar Valley varies from the general history of the main body of the lake in the larger valleys. These differences were the result of such factors as: position of the mountain area, elevation of the valley, size of streams entering the valley, distance of the lake from the base of the mountains, and the size of the valley.

Because of the elevation of the valley, Lake Bonneville ceased to exist as a lake in northern Cedar

Valley at the close of the Bonneville stage. This resulted in a large quantity of fluvial sediments being deposited in the valley during the Provo stage and continuing, with a decrease in volume, into Recent times. In addition the Provo stage is possibly represented by lake sediments in the lower portion of the valley.

Since 1884, a total of 51 wells have been dug or drilled in the valley. Twenty-six of these are still being used. No well in the valley discharges more than 562 gallons per minute, and most discharge considerably less. The water table varies throughout the valley depending on the fineness of the sediments. There are 12 flowing wells in the valley totaling no more than 150 gallons per minute. During the summer of 1959 only 7 pump wells were operating in the valley, with a total discharge of 4 sec.-ft. In the area of these 7 pump wells the piezometric surface has dropped 51 ft. since 1951.

Four springs occur within or around the periphery of the valley. These springs have a total flow of 6 sec.-ft. The 3 springs near Cedar Fort are bedrock springs and the single spring W. of Fairfield is located on the toe of an alluvial fan.

The Paleozoic rocks that plunge under the valley contribute ground water to the valley, but the quantity is unknown. The major source of ground water in the valley is the pre-Lake Bonneville sediments which are extremely thick and permeable in certain areas. A minor source of ground water is the Lake Bonneville and post-Lake Bonneville sediments.

Meltwater from the winter snows in the Oquirrh Mountains is the major source of ground-water recharge for northern Cedar Valley.

The most promising areas for maximum ground water development are the toes of the alluvial fans along the N. and W. sides of the valley. The least promising area is the flat floor of the valley.--Auth.

12. MINERAL DEPOSITS

See also: Geologic Maps 2-2479; Areal and Regional Geology 2-2480; Geophysics 2-2608; Geochemistry 2-2624; Mineralogy 2-2627, 2-2637; Igneous and Metamorphic Petrology 2-2653.

2-2680. Magakyan, I.G. A METALLOGENIC MAP OF THE WORLD. Translated by Royer and Roger, Inc.: Internat. Geology Rev., v. 2, no. 6, p. 489-497, 2 maps, 2 tables, June 1960.

This describes a metallogenic map of the world, compiled at 1:22,000,000, which relates geologic structural elements with principal mineralization processes and recognizable regularities in the distribution of metallic ores. The structural elements delineated include 2 types of shield areas and 5 types of mobile folded zones, the latter distinguished on the basis of age of folding. The types of mineral deposits recognized are: 1) magmatic, 2) pegmatitic, 3) skarn, 4) hydrothermal, 5) sedimentary, 6) deposits resulting from metamorphism, 7) weathering, and 8) diamond deposits of all kinds. The specific ore deposits are classified as either 1) very large deposits of world importance, or 2) other industrial deposits. Shield areas are typically associated with such ore formations as metamorphic deposits of Fe, Mn, Au, U, sulfide deposits of Cu-Ni, and rare-metal pegmatites. Within mobile folded zones, mineralization usually manifests 4 successive stages, each characterized by a specific metallogeny and isolated in space.--M. Russell.

2-2681. Shatalov, E.T. THE METALLOGENY OF ORE DISTRICTS: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 9, p. 28-40, pub. May 1960, 28 refs.

This article stresses the great importance of a detailed study of the metallogeny of ore districts. The author describes the basic principles and possibilities in the development of methods for such study and for the construction of metallogenic and forecasting maps of ore districts.--Auth.

The basic theory and methods of metallogenic research were put forward by S.S. Smirnov and Yu. A. Bilibin. They defined 3 types of forecasts: 1) district forecasts, based on the study of metallogeny of whole provinces and belts with geological 1:500,000 maps; 2) regional forecasts and metallogenic studies of ore-bearing regions to determine possible ore fields, using 1:50,000 or 1:25,000 geological survey maps; 3) large scale forecasts, determining the importance of recently found ore fields and deposits, using 1:10,000 maps and special studies of these deposits.--LC.

2-2682. Vaughn, W.W., E.E. Wilson, and J.M. Ohm. A FIELD INSTRUMENT FOR QUANTITATIVE DETERMINATION OF BERYLLIUM BY ACTIVATION ANALYSIS: U.S. Geol. Survey, Circ. 427, 9 p., 8 figs., 1960.

A field instrument for determining the Be content of a hand-crushed rock sample in the range from 1 to 20% BeO is described. The accuracy of the instrument is estimated to be $\pm 0.25\%$. The physical and electrical design is discussed in detail. Possible adaptions of the technique to other forms of instrumentation are suggested.--U.S. Geol. Survey.

2-2683. Illsley, C.T., and Ross L. Kinnaman. MOBILE AND PORTABLE UNITS FOR GEOCHEMICAL EXPLORATION FOR URANIUM: U.S. Atomic Energy Comm., [Pub.] RME-131, 27 p., 3 illus., 3 diags., 4 tables, July 1959, 9 refs.

Geochemical exploration for U ore deposits usually requires prompt delivery of reliable analytical data to the field party. This is true of both hydrogeochemical and soil sampling projects since specific areas must be selected as soon as possible after initial sampling. Prompt and reliable analytical data can most rapidly be obtained with a mobile geochemical laboratory located at a base camp near the area of interest, such as described in this report.

Exploration projects which require a field party to be absent from the base camp for long periods of time can include hydrogeochemical sampling if a portable kit is carried into the field. This report describes a portable geochemical kit equipped for extracting U from water samples and measuring the pH and conductivity of the water on the spot.

Analytical procedures are given for determining the U, bicarbonate and sulfate content in waters. Lists of the necessary equipment and supplies required for both mobile and portable equipment are presented.--Auth.

2-2684. Walton, Harold F. URANIUM GEOCHEMISTRY IN THE ROCKIES: Chem. & Eng. News, v. 38,

no. 25, p. 118-122, June 20, 1960.

A team of researchers studied the chemistry of ground waters and springs in the Gas Hills area of Wyoming and elsewhere, to explain the why and where of U deposits. "Almost every secondary U deposit in the Rocky Mountain area ... is associated with organic matter in some form. The presumption is strong that this organic matter acts as a reducing agent. In short, oxidizing water dissolves U; reduction precipitates it."--Worldwide Mining Abstracts, v. 7, no. 4, p. 7, July-Aug. 1960, abs. 74-B6.

2-2685. Miesch, Alfred T., Eugene M. Shoemaker, William L. Newman, and Warren I. Finch. CHEMICAL COMPOSITION AS A GUIDE TO THE SIZE OF SANDSTONE-TYPE URANIUM DEPOSITS IN THE MORRISON FORMATION ON THE COLORADO PLATEAU: U.S. Geol. Survey, Bull. 1112-B, p. 17-61, map, 2 diags., 9 graphs, 9 tables, 1960, 14 refs.

The concentrations of U, Y, Na, Fe, Zr, Mn, Ca, and Ni in 75 mill-pulp samples of U deposits in the Salt Wash member of the Morrison formation [Jurassic] on the Colorado Plateau have been found, by statistical tests, to be significantly related to the size of the deposits represented by the samples.

The elements mentioned above are related to the formation of the deposits in a variety of ways. Zr is an intrinsic element, contained principally in the detrital syngenetic fraction of the host sandstone. Ca, Mn, and Na are intrinsic elements contained principally in epigenetic (diagenetic) carbonate in the host sandstone. U, Y, and Ni are principally extrinsic elements, introduced into the host sandstone by U mineralization or related processes. Somewhat more than half of the Fe is probably intrinsic and the remainder is extrinsic.

Three methods can be used to estimate the size of U deposits in the Salt Wash member within broad limits. Method 1 is based on simple linear-regression theory; method 2 is based on multiple-regression theory (long method); and method 3, on multiple-regression theory (short method).

For methods 1 and 2 the estimated log size of each deposit can be computed from tables showing the known concentration of U, Y, Na, Fe, Zr, Mn, Ca, and Ni in the deposits, as determined by semiquantitative spectrographic analysis. For method 3 the estimated size or log size can be read directly from a table showing known concentration of U and Y only.

About 80% of the tonnage-size estimates from method 1 will be within a factor of 13 (12-14) of the true sizes. The precision of the size estimates from method 2, the long multiple-regression method, is highly variable. Some estimates from method 2 will be within a factor of 12 of the true size at the 80% confidence level; others, within a factor of 40 at the 80% confidence level. About 80% of the tonnage-size estimates from method 3, the short multiple-regression method, will be within a factor of 15 (13-16) of the true size.

A group of 40 deposits of known size was used to test the theoretical derivation of the confidence intervals given above. It was concluded from the test that the confidence intervals describe the precision of the methods correctly.

The methods for estimating the size of U deposits are useful where the ore is poorly exposed or where an independent estimate is desired. The error of the estimates may be quite large, as indicated by the confidence limits given above; but the estimates can be used to, at least, distinguish very large from very small deposits. They also may serve to encourage or discourage further expenditures in the development and exploration of ore bodies. The methods of size estimation can be particularly useful in attempts to appraise or compare groups of deposits or mining districts, inasmuch as the average estimate of size of deposits in a group is more precise than any single estimate.

The methods for estimating size are established only for deposits in the Salt Wash member of the Morrison formation. Tests indicate that the equations calculated for deposits in the Salt Wash fail completely if applied to deposits in other stratigraphic units, such as the Moss Back and Shinarump members of the Chinle formation [Upper Triassic]. A further restriction, not completely evaluated at present, is that semiquantitative spectrographic analyses of mill-pulp samples are required. No tests have been made to determine the precision and accuracy of the methods when other types of samples, such as drill core, are used.--Auth.

2-2686. Froelich, Albert J., and Frank J. Kleinhampl. BOTANICAL PROSPECTING FOR URANIUM IN THE DEER FLAT AREA, WHITE CANYON DISTRICT, SAN JUAN COUNTY, UTAH: U.S. Geol. Survey, Bull. 1085-B, p. 51-84, 2 maps (1 in pocket), 2 graphs, 2 tables, 1960, 12 refs.

The plant-analysis method of botanical prospecting for concealed U deposits was employed from May to July 1953, in the Deer Flat area, White Canyon district, San Juan County, Utah. About 2,000 samples of tips of branches from as many junipers and pinyons were systematically collected along about 27 mi. of outcrop of the Shinarump member of the Chinle formation of Triassic age or of laterally equivalent units and were analyzed in the laboratory for U content. Anomalously large amounts of U absorbed by trees imply a nearby source, which may be an ore deposit. The indicator-plant method of prospecting did not prove very useful in the Deer Flat area.

Botanically defined anomalies occur at all major known deposits at Deer Flat. Other botanically defined anomalies may reflect previously unknown mineralized parts of the Shinarump member. The distribution of botanical anomalies suggests that the S. half of the Deer Flat area is much more favorable for concealed U deposits than the N. half.

Additional physical exploration is recommended at Deer Flat to test the validity of the plant-analysis method of prospecting for U. The finding of mineralized ground at botanical anomalies would verify the reliability of the botanical-prospecting method for defining mineralized areas.--Auth.

2-2687. Kleinhampl, Frank J., and Carl Koteff. BOTANICAL PROSPECTING FOR URANIUM IN THE CIRCLE CLIFFS AREA, GARFIELD COUNTY, UTAH: U.S. Geol. Survey, Bull. 1085-C, p. 85-104, illus., 2 maps (1 col. in pocket), 3 tables, 1960, 22 refs.

The plant-analysis method of botanical prospecting may be used to locate U deposits in the Circle Cliffs area where the deposits lie as much as 70 ft. beneath the surface of benches developed on the Shinarump member of the Chinle formation [Upper Triassic]. The Shinarump underlying the benches is thicker than 70 ft. at many places, however, and thus restricts the use of the plant-analysis prospecting method. The plants Astragalus pattersoni and Stanleya pinnata broadly define some uraniferous localities adjacent to the contact of the Moenkopi formation and the Shinarump member of the Chinle formation, but

the general paucity of Astragalus in the Circle Cliffs area limits the usefulness of this genus. Astragalus pattersoni, Stanleya pinnata, and Aster venustus? may serve as guides to mineralized parts of the Salt Wash sandstone member of the Morrison formation [Jurassic] in the Circle Cliffs area. Thick and thin units of sandstone of the Shinarump member generally can be distinguished by studies of the ratios of pinyons to junipers. These studies may supplement drilling to define channel-fill sandstone, which is associated with ore deposits in the Circle Cliffs area. Ratio studies appear to be applicable to other areas throughout the Colorado Plateau where similar geologic and ecologic conditions exist.--Auth.

2-2688. Bloss, F. Donald, and Robert L. Steiner. BIOGEOCHEMICAL PROSPECTING FOR MANGANESE IN NORTHEAST TENNESSEE: Geol. Soc. America, Bull., v. 71, no. 7, p. 1053-1065, 5 maps, 5 tables, July 1960, 2 refs.

Samples of mature leaves and second-year twigs were collected from 36 chestnut oaks (Quercus prinus L.) growing above 2 areas of subsurface Mn mineralization in NE. Tennessee. Of the metals determined to be most abundant in ore specimens and concentrates from the general area (i.e., Mn, Fe, Ba, Co, and Ni in decreasing order of abundance), all but Co were readily determinable spectrochemically in the ashes of leaves and twigs. The average values (weight per cent) for the tree samples collected as well as for soil specimens from the 1-ft. depth at each tree locale were:

	Mn	Ba	Fe	Ni
Twig ash	3.8	1.01	0.24	0.017
Leaf ash	3.8	0.36	0.35	0.014
Nearby soil	0.29	0.04	6.9	<0.001

Two areas were sampled; one, the Hutchens property, was later developed into an economic ore body. The Mn bodies of the second, the Rominger property, proved to be too low in over-all concentration to be of economic value. Significantly, the samples from the Hutchens area more frequently exceeded the average values for Mn, Ba, and Ni given in the preceding table than did those from the Rominger area. Although Ni was not detectable in the surface soil, the appearance of Ni in excess of average in chestnut-oak leaf and twig ash was confined almost exclusively to the Hutchens area, particularly to the trees most closely overlying the subsurface Mn ore body. Ni in chestnut-oak leaf and twig ash thus seemed to be a fairly reliable guide to ore, apparently acting as a pathfinder for Mn.--Auth.

2-2689. Bichan, W. James. THE ORIGINS OF THE MASSIVE SULPHIDES, PART II. Can. Mining Jour., v. 81, no. 5, p. 69-72, May 1960, 12 refs.

Evidence for a direct magmatic origin for massive sulfide bodies is expanded to include the ore bodies at Sudbury, Ontario, Flin Flon, Manitoba, Sullivan, British Columbia, and Britannia, British Columbia. It is suggested that studies of the massive sulfides should include recognition of the fact that pyrite in massive form is a monomineralic igneous rock and that massive pyrite bodies have crystallized from a liquid "matte." It is further suggested that some vein sulfides have crystallized from pockets of liquid matte.--W.C. Peters.

2-2690. Pavlov, N.V. PROBLEMS OF THE GENESIS OF THE ENDOGENETIC MAGNETITE ORES OF THE TUNGUSSKA [SIC] SYNECLISE ON THE SIBERIAN PLATFORM: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1958, no. 9, p. 1-17, 6 maps, 2 secs., pub. May 1960, 18 refs.

Before 1931, the Fe ore deposits of the Angara-Ilim region of the Tunguska syneclise attracted little attention. Geologists connected their formation with thermal activity of basic volcanic minerals, and it was considered that basic magma could not form large accumulations of ores, because of the low content of volatile mineralizers. In 1931, S.S. Smirnov estimated that reserves were in the hundreds of millions of tons, and that the ore formation process is genetically connected with plutonic magmatic sources of basic rocks rich in volatile mineralizers. The presence of such volatile components was indicated by large pneumatolytic and hydrothermal aureoles of transformed rock containing the ore bodies. His theory was substantiated by later research. The Tunguska syneclise covers an area of more than 1,000,000 sq.km. Four large Fe ore regions are there: 1) the Angara-Ilim region; 2) the Tunguska river Fe ore field; 3) the Podkamennaya Tunguska river-Bakhta region; and 4) the Ilimpeya river region. The study of all these regions showed a close connection of the ore-formation process with disruptive dislocations which preceded the period of ore formation. The sources of minerals, which formed the magnetite deposits, were the ore-bearing solutions separated in various periods from plutonic sources of the basaltic magma which, before the ore formation in the upper levels of the plateau, formed the trap rocks. Zones of breaks served as ways of penetration for basaltic magma which formed the traps.--LC.

2-2691. Pavlovsky, E.V., and V.G. Belichenko. UPPER PROTEROZOIC FORMATIONS OF THE SAYAN-BAYKAL UPLAND AND ORE MINERALS ASSOCIATED WITH THEM. Translated by Royer and Roger, Inc.: Internat. Geology Rev., v. 2, no. 6, p. 461-475, map, 2 secs., June 1960, 33 refs.

Great thicknesses of late Proterozoic sediments (described in some detail) fill the composite miogeosyncline of western Baikal and the interior eugeosynclines from which it is separated by anticlinorial uplifts of older rocks. Deposits of P, Mn, and Fe are localized stratigraphically within the synclines. Small quantities of extrusive rock are dispersed through parts of the miogeosyncline; within this structure, metamorphism is generally low grade, and exogenic mineralization is reflected possibly in chrysocolla cements and nodules at lower horizons. In the eugeosyncline, extrusives bulk large, and lit-par-lit injection and contact metamorphism from late Proterozoic and Mesozoic intrusives are appreciable. "Flyschlike" deposition closes sedimentation in all of the troughs, and P ores of the miogeosyncline and Fe and Mn ores of the eugeosyncline, occur in the immediately underlying formations. The phosphorite occurs as oölitic francolite associated with tuffaceous material on the flank of the geosyncline, in sandstones, shales, and limestones. The Mn and Fe ores also occur in the geosyncline flanks, in marbles intercalated with hematitic and siliceous shales. The chief ore minerals are braunite, hausmannite, rhodochrosite, hematite, and magnetite. Rhodonite and spessartite occur in skarn deposits. The association of extrusive and intrusive rocks with ores, and the uniform stratigraphic position of P, Fe and Mn deposits are taken to signify origin from deep

seated emanations, via fissures, induced by geosynclinal subsidence, with ore localization controlled by permeability.--Z.S. Altschuler.

2-2692. Salmon, John. "HERE'S RICH GOLD": Can. Mining Jour., v. 81, no. 7, p. 72-75, July 1960.

Illustrations of bonanza Au occurrences are given from the records of the last hundred years or so.

The richest pannings on record were taken from the Feather River, California; one panful yielded $4,000 in gold. Thousand dollar panfuls were reported from the Koyukuk River, Alaska. Mention is made of record panfuls from early day camps in Montana, the Yukon, Australia, British Columbia, Idaho, and Arizona.

Record sluice-box and rocker yields are discussed. Record chunks and nuggets are mentioned, the largest of which were from California and Australia.

Exceptional pockets, shoots, and single carloads are noted, the richest carload shipment being 47 tons of ore netting $574,958 from Goldfield, Nevada. --W.C. Peters.

2-2693. Cheriton, C.G. COPPER-SKARN MINERALIZATION IN NORTHERN BRITISH COLUMBIA: Can. Mining Jour., v. 81, no. 4, p. 99-101, 3 maps, Apr. 1960.

Prospecting for Cu within and adjacent to skarned carbonate rocks is practiced in British Columbia but has received little attention in the Canadian Appalachian regions. It is suggested that skarn areas in northern New Brunswick be investigated for deposits similar to the Gaspé Cu deposit in Quebec. The nature and origin of skarn mineralization is considered and comments are made regarding the magnetic characteristics of skarn areas.--W.C. Peters.

2-2694. Davies, J.F. GEOLOGY OF THE THOMPSON - MOAK LAKE DISTRICT, MANITOBA: Can. Mining Jour., v. 81, no. 4, p. 101-104, 2 maps, Apr. 1960, 4 refs.

New Ni mining, concentrating, smelting, and refining facilities are being developed in the Thompson area, Manitoba. The Thompson deposit and other Ni deposits in the area occur along a major Precambrian structural trend. Bedrock is principally schist, gneiss, granitic gneiss, and some volcanics, with numerous small serpentinite intrusions. The structural zone, with its parallel gravity low and high trends, lithology, and undifferentiated serpentinite intrusions, is similar to major Alpine structures and island arcs.

Ni deposits are unusual in that the higher grade bodies occur in gneiss rather than serpentine. Gravity data indicate that the structural trend and possible additional Ni deposits lie beneath Paleozoic limestones to the NE. in the Hudson Bay area and to the SW. in the Lake Winnipeg area.--W.C. Peters.

2-2695. Nelson, Russell C. WORLD MOLYBDENUM AND TUNGSTEN RESOURCES: Eng. & Mining Jour., v. 161, no. 5, p. 93-97, map, May 1960.

Analysis, tabulation, and listing of all the important deposits, with production and reserves data, broken down by continents. The United States W-Mo resources are presented with a numbered map, locating each operation or reserve.--Worldwide Mining Abstracts, v. 7, no. 4, p. 9, July-Aug. 1960, abs. 74-C13.

2-2696. Eldorado Mining and Refining Ltd. ELDORADO BEAVERLODGE OPERATION: GEOLOGY: Can. Mining Jour., v. 81, no. 6, p. 84-98, 7 illus., 4 maps, 4 secs., June 1960, 17 refs.

The Beaverlodge U deposits in northern Saskatchewan are in Precambrian rocks 100 mi. E. of the Paleozoic cover. The rocks are separated into 2 generalized divisions: the complexly folded sedimentary and granitized Tazin group and an overlying sequence of unmetamorphosed sediments and volcanics.

Most of the economic U deposits occur on secondary fractures related to major faults. With the exception of one ore body, however, none are immediately adjacent to major faults.

The principal U mineral is pitchblende. Uranophane is also mined. Minor noncommercial quantities of cobalt-nickel arsenides, lead and copper selenides, and iron vanadate have been recognized. Gangue minerals are principally quartz, hematite, calcite, and pyrite.

Geologic detail is given for each of the mines including operations along the St. Louis fault, the Martin Lake property, the Eagle property, and the Fish Hook Bay property.

An account is presented of the organization and activities of the geology department at the Eldorado Beaverlodge operation. Detail is included concerning grade control, sampling, drilling, office procedure, and use of a mine model.--W.C. Peters.

2-2697. Wright, Laurence B. GEOLOGISTS FIND 132 MILLION TONS LOW GRADE IRON ORE: Mining World, v. 22, no. 3, p. 26-31, March 1960.

Eight major deposits of concentrating grade magnetite have been found in the Mineral Lake district, SE. of Lovelock, Nevada. Exploration is continuing. --Worldwide Mining Abstracts, v. 7, no. 3, p. 9, May-June 1960, abs. 73-C15.

2-2698. Holz, Peter. AFRICA'S IRON ORE RESOURCES TODAY: Can. Mining Jour., v. 81, no. 7, p. 68-71, 2 illus., map, July 1960.

Fe ore resources in Africa total some 119,427,000,000 metric tons of ore with a metal content of 57,221,000,000 metric tons. In comparison, the United States and Canada possess 75,155,000,000 metric tons of ore with an Fe content of 27,709,000,000 metric tons.

Detail is given for Fe ore resources of the Union of South Africa, the Central African Federation, Angola, Sierra Leone, the United Arab Republics and the Sudan, French West Africa, Tunisia, Algeria, Morocco, and Liberia.--W.C. Peters.

2-2699. Maksimov, A.A. TYPES OF MANGANESE AND IRON-MANGANESE DEPOSITS IN CENTRAL KAZAKHSTAN. Translated by Royer and Roger, Inc.: Internat. Geology Rev., v. 2, no. 6, p. 508-521, illus., map, sec., 2 diags., June 1960, 14 refs

The most widespread ore deposits and occurrences in the central Kazakhstan area are the Mn deposits, numbered in the hundreds. These differ in their metal content, origin, the completeness with which they have been studied, and in their economic value. Many Mn ore formation areas have been exploited industrially; others are being prospected and fairly thoroughly studied. Most of the ore occurrences have been given very little study, however, so that each year investigations reveal new localities of Mn ore

formation, whose study and evaluation is one of the most important tasks faced by geologists working in Kazakhstan.

During the past 10 or 12 years, central Kazakhstan Mn deposits have been the subject of a large number of papers describing the deposits and examining their genesis and industrial value. Extensive exploration, prospecting, and survey work by the numerous geological organizations in central Kazakhstan have produced new data more accurately defining these deposits and adding to earlier known facts on their geology. But the great scale of these geological investigations has created a number of problems for geologists in correctly estimating surface outcrops of Mn ore deposits and occurrences. This paper is an attempt to describe the chief genetic types of central Kazakhstan Mn deposits and to estimate their economic value. The present article cannot, of course, pretend to any exhaustiveness, in that future investigations may well discover new genetic types or modify the industrial value of those already distinguished.--From auth. introd.

2-2700. Johnson, Meredith E., Frank J. Markewicz, and Daniel G. Parrillo. THE TITANIUM SANDS OF SOUTHERN NEW JERSEY: 15 p., 2 maps, chart, 2 secs., 4 tables, Trenton, New Jersey, Bureau of Geology and Topography, [1959], 5 refs.

An expanding need for ilmenite and the inference that geologic conditions were favorable for discovering local deposits prompted the successful search for ilmenite-bearing sands in the Coastal Plain province and in the vicinity of Lakewood, Lakehurst, and Colliers Mills, southern New Jersey. Criteria used in the search were: a) selection of a potentially favorable area, b) emphasis on the Cohansey-Kirkwood contact as a favorable horizon, c) heavy mineral concentrations seen in ditches and the like resulting from recent rainfalls, d) the use of elevations and dips for vertical control, e) color, f) grain size, and g) channel deposits. Reserves, in 14,000 acres of 2 areas, totalling 11,397,000 tons of TiO_2 have been found.--M. Russell.

2-2701. Wright, J.D., and H.R. Oldale. BERYLLIUM PEGMATITES OF SOUTHWESTERN NOVA SCOTIA: Can. Mining Jour., v. 81, no. 4, p. 87-90, 3 maps, Apr. 1960, 3 refs.

In a small area in southwestern Nova Scotia, homogeneous and zoned pegmatites have been recognized. The former appear to have little economic value; in the latter, beryl has been found in clusters in the siliceous core zone, in the border zone, and in fracture fillings. Very little exploration work has been done on the zoned pegmatites and bordering wall rock in the search for beryl and rare minerals. Further exploration is suggested and the berylometer is rated as a useful tool to detect and evaluate the Be content on the spot.--Auth.

2-2702. Johnston, Derek. INDUSTRIAL MINERAL EXPLORATION IN NEWFOUNDLAND: Can. Mining Jour., v. 81, no. 4, p. 91-95, 3 illus., Apr. 1960.

The importance of industrial minerals to the province of Newfoundland is described together with current production, problems, exploration, and prospective developments.

Brief comment is made on the geology of economic deposits of fluorspar, pyrophyllite, gypsum, limestone, clay and shale, sand and gravel. Future developments are anticipated for deposits of asbestos barite, chromite, magnesite, pyrite, and building stone. Labrador's future in producing industrial minerals is mentioned.--W.C. Peters.

2-2703. Finger, G.C., H.E. Risser, and J.C. Bradbury. ILLINOIS FLUORSPAR: Illinois, State Geol. Survey, Circ. 296, 36 p., 3 illus., 2 maps, 2 secs., diag., graph, 4 tables, 1960, 35 refs.

This circular describes in nontechnical form the geology, production, economic aspects, and uses of Illinois fluorspar.

The fluorspar deposits, found principally in Hardin and Pope counties of southeastern Illinois, occur as fissure fillings in faults and as replacement bodies in limestone. Production comes from underground mines. Modern mills up-grade the raw fluorspar ore to provide a finished product for use in the metallurgical, ceramic, and chemical industries. Pb and Zn are important by-products.

Illinois for many years has been the leading producer of fluorspar in the United States, a position due in part to strategic geographical location with respect to water, rail, and highway transportation, and to consuming industries.

More than 50% of the fluorspar produced is used in the chemical industry for the manufacture of hydrofluoric acid, a basic material in production of F chemicals. The metallurgical industry, especially in the open-hearth steel process, consumes about 40% of the fluorspar as a fluxing agent. Most of the remaining fluorspar is used as a flux and opacifying agent in the ceramic industry for the manufacture of glass and for enamel coatings on sinks, bathroom fixtures, stoves, refrigerators, signs, and the like.

F chemicals are useful in Al production, atomic energy processing, rocket and missile fuels, water fluoridation, refrigerants, aerosol propellants, plastics, insecticides, fungicides, medicinals, and in many other specialty products.--Auth.

2-2704. Anderson, Richard C. SAND AND GRAVEL RESOURCES OF CHAMPAIGN COUNTY, ILLINOIS: Illinois, State Geol. Survey, Circ. 294, 15 p., 2 illus., 2 maps (1 in pocket), 3 tables, 1960, 4 refs.

The sand and gravel deposits of Champaign County were laid down by water flowing from melting glaciers that once covered much of Illinois. The deposits are of 3 major kinds: outwash plains, valley trains, and kames. Outwash plains are the major commercial sources of sand and gravel in the county, especially in the vicinity of Mahomet. Remnants of valley trains yield sand and gravel in the NE. corner of the county as does a kame near Mira. Areas that merit further prospecting include outwash deposits near Mahomet, SE. of Rantoul, NW. of Rantoul, along Saline branch, Phinney branch, and Copper slough, and kame deposts in the SW. part of the county.--Auth.

2-2705. Smith, Charles H. DIAMONDS IN THE GREAT LAKES AREA - A GEOLOGICAL ENIGMA: Can. Mining Jour., v. 81, no. 7, p. 51-52, map, July 1960, 4 refs.

The source of diamonds found in the glacial drift of the Great Lakes area is believed to be in the Canadian Shield. Since no diamonds have been found in the glacial drift of Canada, it is not known if the source lies to the N. or S. of the border.

Newly developed prospecting techniques from Tanganyika and Siberia could be applied to heavy min-

erals in the drift to locate indicator minerals such as pyrope. Pleistocene studies could be utilized to trace the heavy indicator minerals rather than the more elusive diamond to the source.--W.C. Peters.

2-2706. Shea, F.S. EXPLORATION ALONG THE WINDSOR-HORTON CONTACT, NOVA SCOTIA: Can. Mining Jour., v. 81, no. 4, p. 105-108, map, Apr. 1960, 6 refs.

The contact zone between the lower Carboniferous Windsor series and Horton series extends through large areas in Nova Scotia. Numerous barite and sulfide deposits occur along the contact; faulting and folding are prevalent and are important in the localization of the mineral deposits. Geochemical and geophysical methods have been found to be particularly suited to prospecting along the Windsor-Horton contact.--W.C. Peters.

2-2707. Ferguson, Stewart A. PROSPECTING ACTIVITIES IN BATEMAN TOWNSHIP, RED LAKE AREA, ONTARIO: Can. Mining Jour., v. 81, no. 4, p. 76-77, map, Apr. 1960.

Geologic mapping and ground magnetic surveying during 1959 in the S. half of Bateman Township is described. The most common rock type is a uniform fine-grained andesite. Occurrences of pillow lava and variolitic pillow lava have been mapped. Interflow sediments include lean Fe formation, cherty sediment, and some slaty bands. Occurrences of acidic volcanics, Fe formation, argillite, and graywacke are noted. Mention is made of basic and ultrabasic intrusives, acidic intrusives, and metamorphics.

Regional structure, strongly magnetic zones, and existing mining properties are briefly described.--W.C. Peters.

2-2708. Green, L.H., J.A. Roddick, and J.O. Wheeler. A GEOLOGICAL RECONNAISSANCE OF PELLY MOUNTAINS AND VICINITY, SOUTHEASTERN YUKON: Can. Mining Jour., v. 81, no. 4, p. 96-99, 2 maps, sec., Apr. 1960, 9 refs.

Geology is summarized and operational detail is given for a reconnaissance, Operation Pelly, by the Geological Survey of Canada during 1958 and 1959. The area, comprising 13,000 sq. mi. in the southeastern Yukon, is underlain by several NW.-trending zones of metamorphics, granitic rocks, unmetamorphosed Paleozoic sediments, and volcanics. The central belt of Paleozoic rocks, characterized by extensive thrust faulting, contains most of the mineral deposits in the area. Favorable areas are mentioned for prospecting for deposits of Ag-Pb, Cu, W, Mo, asbestos, Ni, and Cr.--W.C. Peters.

2-2709. Vogel, John D. GEOLOGY AND ORE DEPOSITS OF THE KLONDIKE RIDGE AREA, COLORADO: U.S. Geol. Survey, Repts., Open-File Ser., no. 509, 206 p., 18 illus., 14 maps (12 in pocket incl. col. geol. map, scale 1:24,000, col. geol. map, scale 1:12,000, and 9 col. geol. maps, scale 1:9,000), 3 secs. (in pocket), 22 tables, 1960, 91 refs.

The region described in this report is in the northeastern part of the Colorado Plateau and is transitional between 2 major structural elements. The western part is typical of the salt anticline region of the Plateau, but the eastern part has features which reflect movements in the nearby San Juan Mountains.

There are 5 major structural elements in the report area: the Gypsum Valley anticline, Dry Creek basin, the Horse Park fault block, Disappointment Valley, and the Dolores anticline. Three periods of major uplift are recognized in the southeastern end of the Gypsum Valley anticline. Each was followed by collapse of the overlying strata. Erosion after the first 2 periods removed nearly all topographic relief over the anticline; erosion after the last uplift has not yet had a profound effect on the topography except where evaporite beds are exposed at the surface.

The first and greatest period of salt flow and anticlinal uplift began in the late Pennsylvanian and continued intermittently and on an ever decreasing scale into the Early Cretaceous. Most movement was in the Permian and Triassic periods.

The second period of uplift and collapse was essentially contemporaneous with widespread tectonic activity on the northwestern side of the San Juan Mountains and may have occurred in the Oligocene and Miocene epochs. Granogabbro sills and dikes were intruded during the middle or upper Tertiary in Disappointment Valley and adjoining parts of the Gypsum Valley and Dolores anticlines.

The third and mildest period of uplift occurred in the Pleistocene and was essentially contemporaneous with the post-Hinsdale uplift of the San Juan Mountains. This uplift began near the end of the earliest, or Cerro, stage of glaciation.

U-V, Mn, and Cu ore as well as gravel have been mined in the Klondike district. All deposits are small, and few have yielded more than 100 tons of ore. Most of the latter are carnotite deposits.

Carnotite occurs in the lower part of the basal sandstone unit of the Salt Wash member of the Morrison formation [Jurassic]. Most deposits are in a narrow, elongate "mineral belt" that cuts obliquely across Klondike ridge. The remaining deposits probably form a second "mineral belt" lying about 1/2 mi. to the N.

Mn and Cu deposits show both stratigraphic and structural controls of mineralization. Most Mn deposits are in red beds near Tertiary faults; most Cu deposits, on the other hand, are in brown sandstone, limestone, or gray-green shale and, like Mn, are in or near Tertiary faults.

The Mn and Cu deposits are hydrothermal in origin and were formed in the roots of an ancient hot springs system, now deeply eroded. The ore-bearing solutions probably consisted of dilute, carbonate-sulfate ground water heated by the near-surface intrusion of small bodies of igneous rock. These solutions obtained their metals by leaching the wallrock; little, if any, material was added by the intrusives.

The deposits were formed near the surface under conditions of hydrostatic pressure, and temperatures and pressures in the ore-bearing solutions were probably low. The early solutions were weakly alkaline and reducing in character. A convection cell was established as mineralization progressed, and surface water mingled at depth with the thermal solutions. As a result of mixing and oxidation, the pH of the solutions decreased in later stages of mineralization and the Eh rose.--Auth.

2-2710. Visher, Stephen S. INDIANA'S MINERALS AND THE STATE'S DEVELOPMENT: Indiana Acad. Sci., Proc., v. 68, p. 300-302, 1958, pub. 1959.

The annual value of minerals from Indiana has long been greater than that of 35 other states. Output has been almost altogether of coal, oil, gas, stone gravel, sand, and clay; Indiana has produced almost

o metals. A summary of the development of the industry with significant dates is given.--M. Russell.

13. FUELS

ee also: Geophysics 2-2606; Mineral Deposits 2-2710.

-2711. Hamilton, Robert G. THE REVOLUTION N WELL LOGGING: Oil & Gas Jour., v. 58, no. 6, p. 187-188, 3 tables, June 27, 1960.

In the early years, logs were used principally for correlation and depth control; now they provide valable information about the quantity of oil or gas, ock porosity, salinity of formation waters, and deailed lithographic information. One table shows the ses of various logging devices, the second the chroology of the introduction of the different tools, and ne third classifies well logs and exploration devices requently employed in formation evaluation.--N. treet.

-2712. Blanpied, B.W. EXPLORATORY DRILLNG IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 657-682, 3 maps, 6 graphs, 2 tables, July 1960.

This report, the 15th based on data gathered by he Committee on Statistics of Exploratory Drilling, s the 24th annual summary on the subject published n the Bulletin. Frederic H. Lahee prepared this tatistical analysis and wrote the annual article for 0 consecutive years. Graham B. Moody prepared he report for exploratory drilling for 1956. This is ne third report for the present chairman.

During 1959, 13,191 exploratory holes were drilled n the United States. Of these 7,031 were new-field ildcats, 3,355 were new-pool tests (including newool wildcats, deeper-pool tests, and shallower-pool ests) and 2,805 were outposts. Among the new-field ildcats, 772 were successful, among the new-pool ests 941 were successful, and among the outposts 01 were successful.

The total exploratory footage drilled in the United tates in 1959 was 63,252,521 ft. in the 13,191 holes, r 4,800 ft. per hole. These figures compare with 1,483,911 ft. drilled in 13,199 exploratory holes, ith average depth of 4,661 ft. in 1958.

For the first time we are presenting data on natral gas reserves in the 17 States Area by years, or discoveries having 6 years or more of developent history. For the twelfth time, we are presentng data on Canada and Mexico.--Auth.

-2713. Blanpied, B.W. TRENDS IN EXPLORATORY METHODS BASED ON STATISTICS FROM STUDY OF BASIS OF LOCATION OF NEW-FIELD WILDCAT WELLS: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 7, p. 987-999, 6 graphs, 14 tables, July 1960, ref.

Much information gathered from files of the statistical data presented by members of the Committee on Statistics of Exploratory Drilling is presented herewith for the first time for the states of Texas, Louisiana, and New Mexico in 14 tables. Also, 6 figures are presented for the 12-year period 1948-1959 inclusive, showing statistical percentages in the use of geology, geophysics, and combined geology and geophysics in making new-field wildcat locations. Data show that more than half of the successful technically located wells were located on a geological basis, and approximately 25% on geophysical methods alone.--Auth.

2-2714. Latus, Thomas J., D. Jardine, B.V. Sanford, and J.E.S. Milne. EXPLORATORY AND DEVELOPMENT DRILLING IN WESTERN AND EASTERN CANADA: Can. Oil & Gas Industries, v. 13, no. 4, p. 37-88, Apr. 1960.

Exploration and development in western Canada during 1959 remained about the same as 1958. In southwestern Ontario, 3 significant discoveries were made. In the Maritimes, 8 wells were drilled. Maps, statistics, and a list of oil wells drilled in Canada during the year are included.--Worldwide Oil and Gas Abstracts, v. 5, no. 3, p. 25, May-June 1960, abs. 53-8-1.

2-2715. Jardine, D., B.V. Sanford, and J.E.S. Milne. DEVELOPMENTS IN EASTERN CANADA IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 932-939, 5 maps, 4 secs., 5 tables, June 1960, 6 refs.

Exploratory drilling in southwestern Ontario increased over 1958, but development drilling decreased. Offshore drilling (exploratory and development combined) increased 39% over 1958. Natural gas production increased by 11% to 17,200,000 MCF, and oil production increased 22.3% to 1,001,600 bbls. This constitutes the highest annual production of petroleum ever taken from Ontario oil fields, including the peak production year in 1894 when 829,000 bbls. were recovered.

Three significant discoveries were made in southwestern Ontario: one each in Essex, Elgin, and Halton counties. Tempo of exploration increased noticeably in the Maritimes, where 8 wells totalling nearly 35,000 ft. were drilled. Only 6 wells were completed in Quebec, 5 of these in the St. Lawrence lowlands, although there was evidence of increased interest in the Gaspé Peninsula. No development wells were drilled and no discoveries were made.--Auth.

2-2716. Latus, Thomas J. DEVELOPMENTS IN WESTERN CANADA IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 918-931, 2 maps, 11 tables, June 1960, 17 refs.

Exploration and development activities in western Canada continued at approximately the same level established during 1958. There was a noticeable shift of major operations toward the northern regions, but Alberta still led the other provinces by substantial margins in all phases except surface mapping.

There was no essential change in the over-all number of wells drilled (2,500) although 905 exploratory tests accounted for a slightly greater percentage (up 6.2%) of the total. Success of exploratory drilling increased from 24% to 31% and, for the first time, gas discoveries (142) exceeded oil discoveries (136). The Yukon recorded its first oil and gas discovery, and other important finds were made in the foothills of the Rocky Mountains, northwestern Alberta, and northeastern British Columbia. Development drilling centered mainly in the Pembina, Alberta, and southeastern Saskatchewan oil fields, and southern Alberta gas fields. Rapid exploitation of recent Beaverhill Lake discoveries in the Swan Hills area developed into a major center of activity.

Exploratory methods followed the same pattern

as in previous years. Geophysical work continued to decline sharply (down 30%) particularly in Saskatchewan, and surface mapping increased (up 33%) largely in British Columbia and northern regions.

Crude oil production reached a new high of 184 million bbls., up 12% on 1958 for a cumulative of 1.27 billion bbls. Gas production was up nearly 20% to 480 BCF for a cumulative of 3.97 TCF. Liquid hydrocarbon reserves increased by nearly 350 million bbls. (9 1/2%) to 4 billion bbls., and gas reserves showed a 14% increase to 26.4 TCF.

Land holdings increased by 40% to 366 million acres mainly as a result of acquisition of 106 million acres in the Arctic Islands and 23 million acres in the Territories.--Auth.

2-2717. KING-SIZED GAS WELLS SPARK B.C. EXPLORATION: Oilweek, v. 11, no. 9, p. 68-70, Apr. 16, 1960.

From Fort Nelson [British Columbia] to the Home Celibeta discovery in the Northwest Territories of Canada, the Slave Point Devonian section has been productive in 13 wells in at least 5 separate fields. Pay sections range up to 360 ft. and calculated absolute open flow potentials up to a reported 825 MMCF/d have been recorded.--Worldwide Oil and Gas Abstracts, v. 5, no. 3, p. 25, May-June 1960, abs. 53-8-14.

2-2718. Sawatzky, H.B., R.G. Agarwal, and W. Wilson. HELIUM PROSPECTS IN SOUTHWEST SASKATCHEWAN: Oil in Canada, v. 12, no. 23, p. 54-76, passim, maps, cross-secs., Apr. 4, 1960, refs.

He, possibly originating from radioactive decay of heavy elements, is present in Cambro-Ordovician Deadwood strata. Stratigraphic, structural, and geophysical maps are coupled with a tabulation of 20 anomalies.--Worldwide Mining Abstracts, v. 7, no. 4, p. 7, July-Aug. 1960, abs. 74-B21.

2-2719. Torrey, Paul D. CAN WE SALVAGE ANOTHER 44 BILLION BARRELS?: Oil & Gas Jour., v. 58, no. 24, p. 97-102, 2 maps, 4 graphs, 2 tables, June 13, 1960, 20 refs.

The United States oil resources are tabulated by states for original oil content, total oil produced (to Jan. 1960), API proved reserves, IOCC proved reserves, additional reserves recoverable by new methods, additional reserves recoverable by gas and water injection. API proved reserves have advanced continually since World War II, except for a drop in 1957, and stood at 31,719 million barrels in 1959. The United States dropped from first to fourth place in world's crude oil reserve picture during 1946-1959, and during this period its percent increase in reserves was less than any of the other countries considered. In the same period, Soviet Russia found almost twice the new reserves that the United States found, although even then it dropped from third to fifth place. Actually the economically recoverable reserves by gas and water injection are greater than the primary reserves in many states. The proved recoverable reserves of the United States as a result of gas and water injection are in the range of 45.8 billion barrels rather than 31.7 billion. Thermal recovery methods may even considerably increase this figure. --N. Street.

2-2720. Ospina-Racines, Eduardo. WILDCAT AND EXPLORATORY RISKS. SUCCESS OF EXPLORATORY DRILLING IN UNITED STATES AND ESTIMATE OF RISK INCURRED - ADDITIONAL CONCLUSIONS ON DATA OF A.A.P.G. COMMITTEE ON STATISTICS OF EXPLORATORY DRILLING REPORTED, JUNE, 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 946-951, 2 graphs, table, June 1960.

The annual report on the exploratory drilling in the United States and other countries which engages a committee of the A.A.P.G. and numerous collaborators is a feature of the Bulletin of outstanding importance which merits further study, analysis, and interpretation.

A summary of the conclusions of the committee are presented. It points out what seems to be some of the aims of these annual reports and offers additional conclusions interpreting the data.--Auth. summ

2-2721. Richards, Horace G. DEVELOPMENTS IN ATLANTIC COASTAL STATES BETWEEN NEW JERSEY AND SOUTH CAROLINA IN 1959: Am. Assoc Petroleum Geologists, Bull., v. 44, no. 6, p. 851, June 1960, ref.

Four new producing wells were drilled in the Accident gas field in Garrett County, Maryland. Eight new producing wells were completed in southwestern Virginia, located in Buchanan, Dickenson, and Wise counties. There was no drilling in the old Rose Hill oil field of Lee County, Virginia. Eleven oil tests were drilled on the Coastal Plain of North Carolina, all of which were dry.--Auth.

2-2722. St. John, F.B., Jr., and Tracy W. Lusk. DEVELOPMENTS IN SOUTHEASTERN STATES IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 842-850, 2 maps, 13 tables, June 1960, 8 refs.

Mississippi was the only southeastern state that had an increase in all phases of activity. An all-time high was reached in both drilling activity and production.

Alabama had a considerable increase in drilling activity; however, production and geophysical activity were down from that of 1958.

Drilling activity in Florida was slightly above that of 1958, but production and geophysical work decreased. --Auth.

2-2723. Martz, Walter H., Jr. DEVELOPMENTS IN NORTH MID-CONTINENT IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 742-751, map, 7 tables, June 1960.

During 1959 there were 161 new-field and new-pool discoveries in Kansas. Of this number, 137 were oil discoveries, 22 were gas discoveries, and 2 were discoveries of both oil and gas. In addition there were 32 discoveries of deeper production in previously producing pools and 4 discoveries of shallower production. Of the total new discoveries, 31 were in the new-field category; the remainder were classified as new-pool discoveries.

Kansas produced 119,473,875 bbls. of oil; 5,543,983 bbls. of natural gasoline and LPG; and 595,244,836 MCF of natural gas in 1959.

No successful wildcats were recorded in Iowa or Nebraska (E. of the 98th meridian). There was 2 successful new-field wildcats recorded in Missouri. --Auth.

2-2724. Popenoe, H.L. DEVELOPMENTS IN WEST COAST AREA IN 1959: Am. Assoc. Petroleum

logists, Bull., v. 44, no. 6, p. 901-917, 5 maps, raphs, 8 tables, June 1960, 25 refs.

Washington: Five unsuccessful new-field wildcats e drilled. Exploratory footage totalled 34,688.
Oregon: Five unsuccessful new-field wildcats e drilled. Total exploratory footage was 9,640.
California: Four hundred ninety-eight exploratory ls were drilled with a footage total of 2,772,746. s is an increase of 4.6% in number of wells and 0% in total footage over 1958. Fourteen new fields, l and 6 gas, and 38 pools, 20 oil and 18 gas, were covered. Exploration was 17.4% and 18.9% successful as to wells and footage, respectively, compared with 15.3% and 19.7% in 1958. Approximate duction in 1959 was 307.2 million bbls. crude oil, n 2.1% from 1958, 29.1 million bbls. natural gas uids, and 463.1 billion CF natural gas. Basement s reached in 30 unsuccessful exploratory wells. re were 46 active exploratory wells at the end of year.--Auth.

725. Lian, Harold M. DEVELOPMENTS IN ASKA IN 1959: Am. Assoc. Petroleum Geologists, l., v. 44, no. 6, p. 940-945, 2 maps, 2 tables, e 1960, 28 refs.

Exploratory activity in Alaska increased considerly during 1959. Geophysical surveying and drilling istered the largest increases. Twenty wells were ve during 1959, compared with 12 in 1958. Eight loratory wells spudded during the year, compared h 3 in 1958. Significant exploratory wells were lled in 2 basins never before tested - the Nushagak in in southwestern Alaska and the Koyukuk basin N.-central Alaska. Three development wells re completed in the Swanson River oil field.
A major gas discovery was made on the Kenai insula by the Union Oil Company of California and Ohio Oil Company. The discovery well, Kenai t 14-6, was completed flowing dry gas at a 31,000 F/D rate from the Kenai formation. Two follow- wells were also completed as gas producers.
Twenty oil companies sent field parties into the rious sedimentary basins. At the close of 1959 re were 32,611,079 acres under Federal oil and s leases and 101,639 acres under state of Alaska and gas leases. The state of Alaska offered the st offshore oil and gas leases. Bidding for these s higher than had been anticipated. The state ained $4,021,031.43 from the initial sale.
A substantial decrease in surface mapping and a derate decrease in geophysical activity are in spect for 1960. Drilling will probably remain ar the 1959 level.--Auth.

2726. Budd, Harrell. DEVELOPMENTS IN IZONA AND WESTERN NEW MEXICO IN 1959: n. Assoc. Petroleum Geologists, Bull., v. 44, no. p. 891-900, 2 maps, 5 tables, June 1960.

In 1959, 977 holes were drilled in the Arizona and stern New Mexico district. This represents an inease of 11.4% over the 1958 total of 877 wells. Of e 1959 total, 187 were exploratory holes that reted in 77 successful discoveries and extensions. a result, this district enjoyed a remarkable 41.2% ccess ratio for exploratory holes of all types.
Exploration in the San Juan basin of northwestern w Mexico was directed toward stratigraphic ps in the various Upper Cretaceous units, particrly toward the Gallup and Dakota formations in deeper parts of the basin.
Exploration in Arizona used conventional surface tools such as gravity, seismic, plane table, and core drill. The Black Mesa basin of Arizona continued to undergo moderate wildcat drilling. The results were very disappointing except in one case where a new-field wildcat discovered oil in a porous dolomite of Mississippian age. This is the first commercial Mississippian production in the area.

In the Lucero basin of W.-central New Mexico several wildcats were drilled on surface structures that encountered varying thicknesses of porous marine Permian sandstones and Pennsylvanian limestones. This porous marine carbonate section in the Pennsylvanian stimulated an active lease play with plans for several more wildcats to be drilled in the area in 1960.

There were 12,765,761 bbls. of oil, 308,435,489 MCF of gas, and 803,018 bbls. of condensate produced in the Arizona and western New Mexico district during the year.--Auth.

2-2727. Blanton, Sankey L., Jr., and Robert W. Duschatko. DEVELOPMENTS IN ARKANSAS AND NORTH LOUISIANA IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 834-841, map, 8 tables, June 1960.

During 1959 Arkansas drilling activity decreased only 4.6% from the previous year. Louisiana had an increase of 9.2% in over-all drilling activity. No competent geophysical data have been available from N. Arkansas. N. Louisiana had a decrease of 17.5% in geophysical activity.--Auth.

2-2728. Hampton, O. Winston, and Raymond C. Blakely. DEVELOPMENTS IN COLORADO AND WESTERN NEBRASKA IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 879-890, map, 6 tables, June 1960, 7 refs.

Nebraska set a drilling record with 951 wells drilled in 1959. Exploratory drilling increased 24.4% while development drilling was up 39.2% from 1958 activity. Forty-three new Cretaceous "D" -"J" fields were discovered in Nebraska in the established trend areas of the Denver basin. Three Pennsylvanian Lansing-Kansas City oil fields were discovered in the Cambridge arch area. Total oil production in western Nebraska for 1959 was 22,584,096 bbls., an increase of 13% over the 19,902,500 bbls. produced in 1958.

Due to a slow down in the Colorado part of the Denver basin, exploratory and development drilling declined in Colorado with a 4.8% decrease in exploratory drilling and a 3.5% decrease in development drilling. This over-all decline was accompanied by an increase in drilling activity in the southeastern and western parts of the state. Thirty-three of the 59 successful exploratory tests in Colorado were "D" -"J" wells concentrated in the sand fairway of the Denver basin, where 24 new fields were discovered. A "J" sand discovery in southwestern Washington County extended the "D" -"J" trend a few miles E. of its previous known limits. Exploration continued along the Las Animas arch in southeastern Colorado where 2 more successful offsets to the McClave Morrow gas field and a Morrow oil discovery inspired new vigor in the search for oil and gas in that area. Western Colorado had the best statistical year in its history, with 102 exploratory tests resulting in 16 new-field discoveries, 3 new deeper-pool pays, and 3 successful outposts, for a total of 22 discoveries and a success ratio of 21.6%. Some of these successes may not be significant from the

standpoint of finding important reserves, however, as indicated by their low initial potentials. Discoveries included a number of Cretaceous producers and a new deeper-pool Weber pay in the northwestern part of the state and 3 Paradox fields in southwestern Colorado. A Utah Mississippian-Devonian discovery by Pure Oil along the Colorado-Utah Lisbon valley trend indicated that increased activity would be forthcoming to test these deeper formations in the Colorado part of the Paradox basin. Total Colorado production for 1959 amounted to 46,444,422 bbls. of oil, a 5% decrease from 59,010,000 bbls. produced in 1958. Total gas production for 1959 was 84,946,402 MCF (wet gas) and 50,012,342 MCF (dry gas).

Exploratory activities in the "D" - "J" fairway of the Denver basin in both Colorado and Nebraska should continue at about present levels, and may increase because of the expiration of major lease blocks and the granting of shorter-term leases within the fairway. Other major exploration for 1960 will be the search for late Cretaceous and early Tertiary oil and gas fields in western Colorado, the search for Pennsylvanian stratigraphic traps and Paleozoic structures throughout Colorado and Nebraska, and the search for Mississippian-Devonian production in the Paradox basin. Seismic and exploratory drilling will probably increase along the Sierra Grande-Las Animas arch in southeastern Colorado, along the Cambridge arch in western Nebraska, and in the Paradox basin of southwestern Colorado.--Auth.

2-2729. Bell, Alfred H., and Jacob Van Den Berg. DEVELOPMENTS IN ILLINOIS IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 717-725, map, graph, 8 tables, June 1960.

In Illinois 2,032 wells were drilled for oil and gas in 1959, a decrease of 12.7% compared with the 2,291 total in 1958. These figures are exclusive of water- or gas-input wells, salt-water disposal wells, and old wells worked over.

Exploratory drilling decreased 16.3%, from 639 wells in 1958 to 535 in 1959. Fourteen new pools, 43 extensions, and 31 new pays in producing areas were discovered in 1959. Total oil production decreased from 80,779,000 bbls. in 1958 to 76,727,000 bbls. in 1959.

Of the 14 new pools discovered in 1959, 3 produced from Pennsylvanian sandstones, 8 from Mississippian sandstones and limestone, 1 from sandstone of Devonian age, and 2 from dolomite of Silurian age.--Auth.

2-2730. Carpenter, G. L., and Howard Smith. DEVELOPMENTS IN INDIANA IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 726-729, map, 3 tables, June 1960.

Oil production in Indiana during 1959 was 2.2% less than it was during 1958; oil production was 11,811,000 bbls. in 1958 and 11,554,000 bbls. in 1959. In addition, the number of wildcat wells drilled in Indiana decreased 8.2% during 1959, from 317 wildcats in 1958 to 291 in 1959. Successful wildcats discovered 11 new pools, 16 extensions, and 5 new pay zones in productive areas during 1959.

The continued search for productive shallow Chester sands, spurred by the discovery of 2 promising pools in Spencer and Warrick counties and the progressive development of pools in Gibson County in Jackson and Hardinsburg sands, accounted for the largest share of drilling for oil in Indiana. Total drilling was 904 wells in 1958 and 910 wells in 1959, an increase of 0.66%.--Auth.

2-2731. Kirch, Robert V. DEVELOPMENT AND UTILIZATION OF UNDERGROUND GAS STORAGE INDIANA: Indiana Acad. Sci., Proc., v. 68, p. 25 264, map, sec., 1958, pub. 1959, ref.

The benefits of underground gas storage are so substantial that gas utilities in Indiana and other states are diligently attempting to discover and develop such facilities. Most underground storage installations are constructed from former natural-gas fields, although in areas lacking these, other permeable formations, sealed above and below by gas-tight rock in a domal structure, have been developed successfully. Indiana possesses limited opportunities for the development of underground storage reservoirs. Currently, 5 gas companies, including an interstate pipeline supplier, have developed, or are developing such reservoirs. They are located in Posey, Pike, Davies, Knox, Sullivan, Monroe, Decatur, Randolph, and Tippecanoe counties. The greatest potential for future development lies in the central and southern sections of Indiana.--M. Russel

2-2732. Love, Donald W., and Donald R. Duncan DEVELOPMENTS IN LOUISIANA GULF COAST IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 827-833, map, 3 tables, June 196 14 refs.

Statistically, the drilling activity in the Louisian Gulf Coast during 1959 showed a substantial increas over the previous year. Drilling operations showe an increase of 13.8% over 1958. In all, 2,294 tests were drilled, 800 of which were exploratory tests (32.7% successful) and 1,494 of which were development wells (77.5% successful). New-field wildcats numbered 272 (12.5% successful) which resulted in the discovery of 34 new fields. Of the new fields, 13 were oil, 17 gas-condensate, and 4 gas discoveries. Onshore the most important new-field discoveries were the Buras field, Plaquemines Parish Bayou Chevruil field, Lafourche Parish, and the Parcperdue field, Vermilion Parish. The most significant onshore additions to reserves were at Sunrise field, Terrebonne Parish, and at Patterson field, St. Mary Parish. The most important offshore discovery was the Block 4 field, Eugene Islan area. The extension at Block 176 field, Ship Shoal area by CATCO appears to be the most significant addition to offshore reserves.

There were 160 new pools and 74 extensions to known fields in 1959. Oil production increased 17. and gas production increased 16.5% over 1958.

Over-all geophysical activity decreased 15.1% from 1958. The seismograph and gravity-meter activity totaled 854 crew-months. There was no core-drill activity registered in the district during 1959.

The prolific Miocene-Pliocene trend in the southern parishes and adjacent offshore areas and the de Oligocene trend of central SW. Louisiana continued to register the majority of the 1959 drilling activity The average total depth of the successful new-field wildcats was 12,310 ft.

Leasing in the U.S.A.-State disputed area was resumed in 1959. Jointly, the state of Louisiana and the Federal Government advertised 84,163 acr and awarded 38,820 acres in the offshore Zone 2 in 1959. The average bonus cost was $2,268.30 per acre.--Auth.

2-2733. Ives, Robert E., and Garland D. Ells. DEVELOPMENTS IN MICHIGAN IN 1959: Am. As

roleum Geologists, Bull., v. 44, no. 6, p. 730-
2 maps, sec., 4 tables, June 1960, 4 refs.

Michigan registered a notable increase in drilling
vity from the previous years. There were 598
pletions as compared with 413 in 1958. Of the
total, 411 were development wells and 187 were
oratory wells. The exploratory wells resulted
7 discoveries and 170 dry holes. Reworking of
r field wells and dry holes resulted in 2 addition-
iscoveries.
Total drilled footage for oil and gas tests was
9,633 ft., classified as exploratory 632,909 ft.
development 1,286,724 ft. In 1958, the footage
led was 1,156,923 ft. Oil produced during the
r totaled 10,438,604 bbls. and gas 15,626,227 MCF.
Three and 4 gravity crews were working in the
e throughout the year. Also 2 seismic crews
re reported for the last half of the year. Most of
geophysical work was concentrated in the south-
tern, southwestern, and western districts.
The major activity for the year was the develop-
t in S.-central Michigan relative to the Albion-
aski-Scipio Trenton-Black River fracture trend.
hty-one wells were completed along the trend dur-
1959 and 2,046,284 bbls. of oil were produced.--
h.

734. Burton, Robert H., and John R. Dyer.
VELOPMENTS IN MONTANA, NORTH DAKOTA,
D SOUTH DAKOTA IN 1959: Am. Assoc. Petro-
n Geologists, Bull., v. 44, no. 6, p. 852-864,
aps, 10 tables, June 1960.

Exploratory drilling decreased sharply in both
ntana and North Dakota, but showed strong gains
South Dakota. The North Dakota exploratory suc-
s ratio was nearly double that of the previous
r, whereas Montana had no new oil field discov-
es, but had the discovery of 3 new gas fields.
ku beds of Devonian age were indicated to be
ductive for the first time in North Dakota.--Auth.

735. Kreidler, William Lynn. 1959 GAS AND
DEVELOPMENTS IN NEW YORK STATE: Am.
oc. Petroleum Geologists, Bull., v. 44, no. 6,
683-687, map, 3 tables, June 1960, 3 refs.

1959 natural-gas production increased 1/3 over
8. Medina sandstone [Silurian] drilling totaled 23
ls, and 15 wells were drilled to the Oriskany sand-
he [Devonian]. There were 234 oil-field develop-
nt wells drilled during 1959. Oil production in-
ased by 12 1/2% because of cessation of voluntary
ration and increased refinery capacities for New
k crude.--Auth.

736. Carlson, Clarence G., Wallace E. Bak-
, and Jack Kume. SUBSURFACE GEOLOGY AND
VELOPMENT OF PETROLEUM IN NORTH DA-
TA: North Dakota Geol. Survey, Bull. 34, p. 123-
, 3 maps, 2 secs., 5 graphs, 3 tables, 1960, 26
s.; reprinted from: Compass, v. 37, no. 2, p.
-143, Jan. 1960.

See GeoScience Abstracts 2-502 for abstract.

737. Alkire, Robert L., Bernard A. Floto,
Allan W. Johnson. OIL AND GAS DEVELOP-
NTS IN OHIO IN 1959: Am. Assoc. Petroleum
logists, Bull., v. 44, no. 6, p. 704-710, map,
tables, June 1960.

This year, 1,096 wells were completed, of which 804 were successful and 292 dry for a percentage of 26.6 failures. For the second year an increase in activity in the search for gas was noted with a corresponding increase in initial volume developed. Average initial for gas wells was 888,000 cu.ft./D. Initial daily for oil wells was 52 BOPD.

A total of 88 exploratory wells were completed, 36 being successful and 52 failures. Highlighting the exploratory drilling is the testing of the deeper sediments of Ohio. Two successes were recorded in or near the Cambro-Ordovician contact: a gas producer in Hinckley Township, Medina County, and an oil well in Bennington Township, Morrow County, about 80 mi. apart. These significant discoveries offer considerable encouragement to the interest directed to the relatively untested and shallow Cambrian and Ordovician sediments present. The interest shown by both major and independent oil and gas companies indicates a number of tests of these sediments will be drilled in the coming year.--Auth.

2-2738. Roberts, M.C. DEVELOPMENTS IN OKLAHOMA IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 752-764, map, sec., 16 tables, June 1960.

Exploratory drilling decreased 14.7% in Oklahoma during 1959 with 21.5% success; development drilling decreased 18.1% with 66.9% success. Significant new-field discoveries include the North Oakwood in Dewey County, the Squaw Creek of Blaine County, an unnamed Hunton field in northern Custer County, the North Orr of Carter County, and the South Holly Creek of McCurtain County.

Improved structural and stratigraphic analysis continues to account for a high exploratory success ratio. This, in turn, has encouraged additional leasing until an all-time high of approximately 65% of the state is under lease.

Seismic activity has increased slightly as compared with previous years. Secondary recovery and production from unallocated "stripper" oil fields continue to account for more than half the oil produced in the state. New types of recovery seem to insure an increasing source of secondary production.--Auth.

2-2739. Lytle, William S. DEVELOPMENTS IN PENNSYLVANIA IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 688-703, 2 maps, 2 secs., 8 tables, June 1960, 34 refs.

Exploration in Pennsylvania during 1959 resulted in the discovery of 1 new gas field, 6 new gas pools, extended several gas-producing areas, and established a new producing-depth record in the state. A number of important dry exploratory tests were drilled during the year. The second offshore well in Pennsylvania, in Lake Erie on Block no. 2, was plugged and abandoned after finding salt water in the Gatesburg (Upper Cambrian) formation. The Block no. 2 lease has been surrendered. A second well will probably be drilled on Block no. 1 lease during 1960. In the Seven Springs field, Somerset County, a new-pool wildcat was successful when Pennsylvania tract 75 no. 3 by Peoples Natural Gas Company found gas in the Onondaga chert (Middle Devonian) at 8,472 ft. This is the deepest producing-depth record in Pennsylvania. The well produced 10,933 MCF of gas without fracturing at a rock pressure of 3,400 p.s.i. in 10 days, and is the discovery well in the Kooser pool. Fayette County had the only new-field discovery in 1959. The Mueller-Herr well no. 1 by Manufacturers Light & Heat Company found gas in the

Onondaga chert on the Laurel Hill anticline, resulting in the discovery of the Ohiopyle field.

Deep exploration (Middle Devonian or older) found 1 new gas field and 5 new gas pools. Of the unsuccessful wildcats, 10 were new-field wildcats and 7 were new-pool wildcats. Two outposts were unsuccessful. There were 83 development gas wells completed and 14 dry holes. The greatest density of deep drilling operations was in the Clearfield County area where the production limits of 3 pools, which had formerly been considered to be separate, were merged into one long field, the Punxsutawney-Driftwood field, extending almost 50 mi. NE. and SW. One hundred twenty two deep wells were completed in Pennsylvania in 1959, with a total footage of 850,025 ft. Of the 122 wells, 89 were gas wells and 33 were dry holes.

A new shallow-sand (Upper Devonian or younger) gas pool was discovered when the Earl Young well no. 1 was drilled by James Drilling Company in Clearfield County. Production was from the Fifth sand. As in 1958 the secondary-recovery projects in the Bradford field and the development drilling in the gas fields dominated the shallow-sand drilling activity during 1959. In all, 628 shallow-sand wells were completed. Of these, 215 were gas wells, 10 were oil wells, 54 were dry holes, and 7 were drilled for underground storage. Three hundred forty two were drilled in connection with secondary-recovery oil operations. In addition to the 628 new wells, 29 shallow-sand wells were deepened. The total footage of the new and deepened wells was 1,452,759 ft.

Oil production decreased from 6,471,680 bbls. in 1958 to 6,160,387 bbls. in 1959. Proved oil reserves were estimated at 113,858,000 bbls. on Dec. 31, 1959. Gas production increased from 104,974,000 MCF in 1958 to 118,862,000 MCF in 1959. Gas reserves were estimated at 1,051,972,000 MCF at the end of the year. More than 68,000 bbls. of distillate were produced in 1959. Companies leased more than 2,000,000 acres for oil and gas exploration. The total footage drilled, both shallow and deep, was 2,302,784 ft.--Auth.

2-2740. Milhous, H.C. OIL AND GAS DEVELOPMENTS IN TENNESSEE IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 715-716, map, table, June 1960.

The 72 test wells drilled in 1959 were almost 3 times the number completed in 1958. Four small oil wells were discovered and one new gas well was still shut in at the end of the year. Total exploratory footage was approximately 56,600 ft. New leasing activity is estimated to have doubled or tripled the acreage under lease a year ago.--Auth.

2-2741. Fox, Bruce W., and Thomas B. Patrick. DEVELOPMENTS IN EAST TEXAS IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 810-818, map, 8 tables, June 1960, 4 refs.

Drilling activity during 1959 was statistically higher than the preceding year. Discoveries indicate no new major fields but should add substantially to the total reserves of the area. There were 23 new-field discoveries: 9 in the Upper Cretaceous, 13 in the Lower Cretaceous, and 1 in the Jurassic. Field extension and new-pool discoveries totaled 33.

Total number of wells drilled increased by 274 from the previous year. Exploratory tests totaled 355, of which 13.8% were successfully completed.

Geophysical activity was 701 crew-weeks. This is a decrease of 8 crew-weeks from 1958, and a continuation of the decline pattern begun in 1953. Core drill activity totaled 53 crew-weeks, an increase of 35 crew-weeks over 1958.--Auth.

2-2742. Stephenson, Larry G. DEVELOPMENTS IN NORTH TEXAS IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 784-793, map, 4 tables, June 1960.

N. Texas continues as an active and major producing area. In all, 3,548 wildcat and development wells were drilled in the 15-county area in 1959, and 72,410,732 bbls. of oil were produced. One hundred fourteen exploratory tests were successfully completed; these include the discovery of 57 new fields and 46 new pools, and the completion of 11 extension wells. Major new production is from the Pennsylvanian Strawn and Aroka. The more significant new discoveries were completed in the Hardeman basin, the Marietta-Sherman basin, and the Muenster arch.--Auth.

2-2743. Gorrod, Herbert M. DEVELOPMENTS IN TEXAS AND OKLAHOMA PANHANDLES IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 765-773, map, 4 tables, June 1960, 5 refs.

Exploratory activity in the Panhandle district during 1959 was up 22.8% over 1958, although the exploratory success rate was down 1.2%. There were 106 completions and 218 dry holes. A large majority of the discoveries were in Pennsylvanian reservoirs in the Anadarko basin; however, deep drilling in the Panhandle and Hugoton fields accounted for many discoveries.

Leasing and geophysical activity decreased and are expected to remain down during 1960.--Auth.

2-2744. Goodwin, Fred, Jr., Martha Bybee, and J.C. Wise. DEVELOPMENTS IN SOUTH TEXAS IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 800-809, map, 4 tables, June 1960.

Drilling activity in S. Texas during 1959 increased 7.5% over the 1958 level. Exploratory drilling declined 14.3% but development drilling increased 19.7. Ninety-six discoveries resulted from 892 wildcats in 1959 for a 10.7% success ratio as compared with 83 new fields from 1,041 wildcats for a 8% success rate in the previous year. The most important discovery appears to be the Brazos Oil Company's Person no. 1 in Karnes County which is the first oil discovery of any magnitude within the downdip Cretaceous (Edwards) trend. Oil and gas production increased slightly but liquids produced from gas wells had a substantial increase. Geophysical activity increased with the largest increase being in the Paleozoic trend.--Auth.

2-2745. Brixey, A.D., Jr., and James W. Alewine. DEVELOPMENTS IN UPPER GULF COAST OF TEXAS IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 819-826, map, 4 tables, June 1960, 13 refs.

This report covers the upper Gulf Coast of Texas located in the southeastern corner of the state and the adjacent Continental Shelf. The area includes 29 counties, comprising Texas Railroad Commission District no. 3.

There was a marked decrease in exploratory drilling on shore, while exploratory drilling offshore

showed a lesser decline over 1958. The total number of both exploratory and field development wells drilled was slightly greater than in 1958. Oil production again declined in 1959. The Texas state-wide number of producing days in 1959 dropped to an average of 9.25 producing days per month compared to an average of 10.16 producing days during 1958 and 14.25 producing days in 1957. Gas production showed a slight increase over 1958.

In 1959, 44 new oil and gas fields were discovered. As in 1958, most of the discoveries were along the deep Frio, Yegua, and Wilcox (Eocene) formational trends. On the Continental Shelf, 5 wildcats were drilled in 1959 versus 6 in 1958, resulting in the discovery of 2 new fields. Exploration and drilling during 1960 is expected to center, as in the past several years, along the Frio, Yegua, and Wilcox trends.--Auth.

2-2746. Womack, William A., Jr. DEVELOPMENTS IN WEST-CENTRAL TEXAS IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 794-799, map, 6 tables, June 1960.

Total drilling activity increased 1.7% in 1959; 2,561 wells were drilled as compared with 2,520 wells drilled in 1958. Exploratory wells totaled 674, a decrease of 30.1% from the 964 the previous year. Development drilling during 1959 increased 7.6% to 1,683 wells as compared with 1,556 in 1958.

Total oil production decreased 2% from 48,928,383 bbls. produced in 1958 to 48,197,523 bbls. in 1959. This decrease is due to a decline in exploratory drilling although the allowable days increased 0.88% from 10.16 days in 1958 to 10.25 days in 1959.

Geophysical activity increased 8.7% in 1959 as compared with the year 1958. Subsurface geological methods were credited with 76.3% of the new discoveries.--Auth.

2-2747. Peek, Charles A., and others. DEVELOPMENTS IN WEST TEXAS AND SOUTHEASTERN NEW MEXICO IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 774-783, map, 2 graphs, 5 tables, June 1960, 12 refs.

The recovery from the 1958 recession is well illustrated in the drilling for and production of crude oil in W. Texas and southeastern New Mexico. In 1959, 7,721 wells of all classes were drilled in this area, being a 23% increase over 1958. The 1,200 exploratory wells made a 9% increase, and the 6,570 development wells made a 27% increase over the previous year. The success ratio decreased slightly as shown by the 23% successful exploratory tests, down 4%, and the 88% success for development wells, down 2%. With comparable allowables and producing days, production for the year was 520,213,777 bbls. of oil, a 19% increase. The most important discoveries were the Forest Oil Corporation and Pan American Petroleum Corporation's Harris no. 1 in Dawson County, Hill & Meeker's Trower no. 1 in Loving County, and the Argo Oil Company's Neal no. 1 in Pecos County. The most spectacular discovery was the Turner's Shannon no. 4-BB in Crockett County.

Exploratory methods followed the same general pattern as in previous years with increased emphasis on subsurface geological methods. Geophysical activity was down 6% from the 1958 level. The Delaware basin, Sheffield channel, and Val Verde basin areas continued to be the most active from the standpoint of seismic work.

Leasing activity continued high in the area with bonus prices increasing and length of primary term decreasing. There was one University Land Sale held with competition less intense than in previous years with the average bonus price decreasing. There appears to be a trend toward more joint ventures and drilling units in both the areas of tightly held acreage and in the more unexplored areas in which the drilling costs are extremely high.--Auth.

2-2748. Preston, D.A., and Graham S. Campbell. OIL AND GAS DEVELOPMENTS IN UTAH AND NEVADA IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 874-878, 2 maps, 6 tables, June 1960.

Exploratory drilling in Utah decreased slightly for the second consecutive year. Drilling was down 9%, footage, 5%. The success ratio for all exploratory wells was up 2%.

Pure Oil Company, in the eastern Paradox basin, recorded perhaps the most significant discovery in Utah since Aneth in its Northwest Lisbon well no. 1 which established production from both Devonian and Mississippian strata.

Geophysical activity was off 20% in Utah. Leasing, although maintained at essentially the same level as the previous year, changed its pattern of intensity. Development drilling accounted for 209 wells, almost 1/3 less than drilled in 1958. Production climbed more than 60% with the major oil fields nearing full development.

Drilling in Nevada was slight with only 2 wells completed during the year. For 1960, increased drilling activity is indicated in the eastern Paradox basin, the Uinta basin, and on the Uncompahgre uplift.--Auth.

2-2749. Tucker, R.C. OIL AND GAS DEVELOPMENTS IN WEST VIRGINIA IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 711-714, table, June 1960.

The total number of wells drilled in West Virginia in 1959, reported to Jan. 21, 1960, was 905, an increase of 67, or 8%. Permits to drill or deepen issued by the Oil and Gas Division of the West Virginia Dept. of Mines totaled 1,007, an increase of 94, or 10%. Abandoned during the year were 242 gas wells and 147 oil wells, or a total of 389 wells. These abandonments are all wells drilled before permits were required (May 1929). No information as to the exact number of abandonments of wells drilled since May 1929, is available as these wells are abandoned under original drilling permit numbers. Wells completed were: gas, 591; oil 37; oil and gas 95; storage, water-injection, brine, rock salt, and pressure wells, 59; dry holes 123; total, 905. Compared with 1958, gas wells increased 106, or 21.8%; oil wells decreased 27, or 42%; oil and gas wells decreased 16, or 14.4%; storage and other wells increased 1, or 1.7%; dry holes increased 3, or 2.5%. Depth of wells ranged from 206 to 8,635, compared with 200 to 8,410 ft. in 1958. Total footage drilled (2,321,474) increased 61,444 ft., or 2.7% over 1958 (2,260,030 ft.). The average depth of wells (2,565 ft.) decreased 132 ft. under the 1958 average (2,697 ft.), or 5%. The total initial daily open flow of the gas wells was 688,121 MCF, an increase of 349,302 MCF, or 103% over the 1958 total (388,819 MCF). The size of the gas wells ranged from 4 to 39,680 MCF, compared with 2 to 17,250 MCF in 1958. The total daily initial oil was 3,408.5 bbls., a decrease of 1,085.5

bbls. under 1958 (4,494 bbls.), or 24.2%. The size of the oil wells ranged from 0.5 bbl. to 220 bbls. daily, compared with 0.5 bbl. to 550 bbls. in 1958. The number of wells drilling or unreported if completed at the end of the year was 447, 94 more than in 1958, an increase of 26.6%.

The average size of gas wells was 1,003 MCF, compared with 627 MCF in 1958, an increase of 376 MCF, or 60%. The average size of the oil wells was 40 bbls., compared with 37.5 bbls. in 1958, an increase of 2.5 bbls., or 6%. Preliminary estimates of production for 1959: gas 205,000,000 MCF, compared with 197,250,000 MCF in 1959, or 7,750,000 MCF, an increase of approximately 4%; oil 2,184,000 bbls., a decrease of 2,500 bbls. under the 1958 estimate (2,186,500 bbls.), or 0.11%. The estimated number of producing wells at the end of 1959: gas 15,800; oil 12,741. A table of operations gives statistics by counties.--Auth.

2-2750. Mees, Edward C. DEVELOPMENTS IN WYOMING AND IDAHO IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 6, p. 865-873, map, 4 tables, June 1960, 10 refs.

The 410 exploratory wells drilled in 1959 represent the greatest number drilled in any year and a 30.7% increase over the previous year. Two hundred ninety-eight wildcats discovered 10 new oil fields and 12 new gas fields, for a success ratio of 7.3% compared with 8.7% in 1958. While seismic activity dropped average well depth and total exploratory footage increased.

The 185 exploratory wells in the Powder River basin resulted in 19 successes, for a success ratio of 10.2% and 5 new-field discoveries. Thirty-seven per cent of all Wyoming exploratory drilling was concentrated on the E. side of the Powder River basin. A success ratio of 22.2% was achieved in the Green River basin by 18 of the 81 exploratory tests being successful. Nineteen per cent of all exploratory drilling was in the Green River basin.

Of the 22 new-field discoveries, 6 were found in the Mesaverde and 5 in the Tertiary. Eleven new fields were discovered in the Green River basin, 5 in the Powder River basin, 5 in the Wind River basin, and 1 in the Big Horn basin.

Stratigraphic exploration was extensive with attention directed toward the Dakota on the eastern side of the Powder River basin and the Tertiary-Upper Cretaceous of the Green River and Wind River basins. The search for gas was greatly accelerated.

The most significant development was the discovery of commercial oil in the Almond on the E. flank of the Rock Springs uplift, previously looked upon as a gas province.

Most of the exploratory drilling in 1960 will probably be concentrated on 1) the eastern side of the Powder River basin in search of Dakota and Minnelusa oil and 2) in the Green River Basin in search of gas and Almond oil.

There was no exploratory drilling in Idaho in 1959. --Auth.

2-2751. Cochrane, Wallace H. WYOMING'S WHEATLAND-GLENDO BASIN: Rocky Mtn. Oil Reporter, v. 17, no. 6, p. 13-15, June 1960; no. 7, p. 17-18, July 1960, 2 maps, 3 charts, 2 tables, refs.

The Wheatland-Glendo basin is in southeastern Wyoming. Limited drilling efforts have not been successful. A geologic report of formations encountered and some conclusions drawn from samples retrieved during exploration. Pt. 2 develops the description of the geology of this area and the possibility of oil and gas incidence. The area is peculiarly adaptable to underground storage, and the author feels that this will be one of the deciding factors in exploitation.--Worldwide Oil and Gas Abstracts, v. 5, no. 4, p. 19, July-Aug. 1960, abs. 54-7-14, 54-7-15.

2-2752. Mina Uhink, Federico. PETROLEUM DEVELOPMENTS IN MEXICO IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 7, p. 1000-1013, 6 maps, chart, 6 tables, July 1960.

Four hundred forty-one wells were drilled in Mexico during 1959 as compared with 379 drilled the preceding year. The average depth per well was increased to 7,035 ft. as compared with an average of 6,958 ft. per well during 1958.

During the year of 1959, 133 wells were classified as exploratory holes, of which 82 were new-field wildcats, resulting in the discovery of 11 new gas and oil fields. Other exploratory holes were classified as follows: 9 new-pool wildcats, 9 deeper-pool tests, 8 shallower-pool tests, and 25 extension wells; 31 of these exploratory holes were completed as producers. Of the total number of wells, 298 were successful. The new fields discovered were located as follows: 1 in the Eocene trend in NE. Mexico, 5 in Cretaceous and Jurassic limestones and calcarenites in the Tampico embayment, and 5 new fields in Miocene sands in the Isthmus and Tabasco region, one of which is an offshore prospect.

The main exploratory effort, as in previous years, was concentrated along the coastal plain of the Gulf of Mexico where all the producing fields are located; however, seismic work in Baja California and gravity work in the Yucatán peninsula and northeastern Chihuahua were continued.

One test was drilled to the Cretaceous in NE. Mexico, and 5 tests were drilled to explore the productivity of the Upper Jurassic and Lower Cretaceous formations in the Tampico embayment. In the Veracruz embayment, as in the past year, drilling activities decreased considerably as only 4 wells were drilled in search of oil: 2 were drilled to the middle Cretaceous, as yet unproductive in this area and 2 to the Eocene and Oligocene.

Crude oil and distillate production in 1959 was 105,758,473 bbls., an increase of 9.5% over the previous year. Total gas production was 329,363,504 MCF, an increase of 79.7% over 1958.--Auth.

2-2753. Clark, E.W. PETROLEUM DEVELOPMENTS IN SOUTH AMERICA AND CARIBBEAN AREA IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 7, p. 1014-1057, 17 maps, 17 tables, July 1960, 19 refs.

Exploration and production activities in 1959 were stimulated in Argentina and Brazil, in a politically inspired effort to achieve self-sufficiency in petroleum, but were depressed in Venezuela, which sells the bulk of its production in competition with other major producing areas of the world.

In South America as a whole, crude oil production in 1959 was 3,244,900 b./d., only fractionally higher than in 1957. There were appreciable increases, as compared with 1957, in Argentina, Brazil, Colombia, and Trinidad, totalling 113,100 b./d.; this was offset by a decrease of 69,000 b./d. in Venezuelan production.

Exploration activities were maintained at a high level in Brazil, Argentina, Bolivia, and Colombia but decreased considerably in Venezuela, where large concession areas were voluntarily surrendered.--Auth.

2-2754. King, Robert E. PETROLEUM EXPLORATION AND PRODUCTION IN EUROPE IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 7, p. 1058-1101, 15 maps, 2 graphs, 8 tables, July 1960, 13 refs.

Petroleum production in Europe outside the Soviet zone increased 7.7% over the previous year, to a rate of 256,700 b./d. Austrian production declined 13.3%, but this was more than offset by a substantial gain in Germany and lesser increases in all other producing countries. In Austria the first important oil field was found in the Molasse basin. In France exploratory drilling continued at a high rate. Important discoveries were made in the Paris and Aquitaine basins. Exploratory drilling declined in Germany. Some apparently significant gas discoveries were made, but most of the oil fields were evidently minor and most were related to previously oil- or gas-bearing structures. Two wells found gas for the first time in the Lower Triassic. In Italy an important gas discovery was made in the Bradanic trough in the southern part of the peninsula, and another in the Po valley. A new oil field was found N. of Gela. Some interesting exploratory wells were drilled in structurally complex parts of the Apennines. In the Netherlands production in the Schoonebeek field declined further, but there was a sharp gain from the small fields in the western part of the country. In England oil was found for the first time in the Jurassic on the S. coast. Exploratory drilling was suspended in Denmark and Portugal after drilling of a number of dry holes. A well in northern Spain drilled to 16,503 ft. and another deep test was drilling at the end of the year. A deep test was drilled in Malta. Plans were made for drilling in Switzerland in 1960. Negotiations for concessions were made in Belgium, Eire, and Greece. Some data on production and exploration in the Soviet Union are included in the paper.--Auth.

2-2755. Hotchkiss, Henry. PETROLEUM DEVELOPMENTS IN MIDDLE EAST AND ADJACENT COUNTRIES IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 7, p. 1144-1178, 18 maps, graph, 29 tables, July 1960.

Petroleum production in the Middle East countries in 1959 totalled 1,678,553,000 bbls., an average of 4,598,606 b./d. This is comparable with a total production of 1,559,533,000 bbls. in 1958 - an average of 4,272,884 b./d.

Production in Pakistan in 1959 totalled 2,335,000 bbls., an average of 6,398 b./d. This compares with a total of 2,271,379 bbls. in 1958, an average of 6,207 b./d.

Production in India during 1959 is estimated to have totalled 3,467,000 bbls., an average of 9,500 b./d. This compares with an estimated production of 3,102,000 bbls. in 1958, an average of 8,500 b./d.

Although 3 new districts were opened for bidding in Iran during 1959, the only important concession granted anywhere in the Middle East or adjacent countries during the year was in the Yemen. Some renewed interest in Lebanon was shown.

Drilling commenced in 3 offshore licenses in the Persian Gulf during the year. With the exception of the above, exploratory effort, in general, remained at about the 1958 level. A possibly commercial discovery was made in the Syrian region of the U.A.R. Some small gas accumulations were noted in Pakistan and gas shows were recorded in Israel.

Expansion in production, pipe line, and/or terminal facilities was underway or completed in Iraq, Iran, Kuwait, Saudi Arabia, and India. Refining capacity is being increased in Turkey and India.--Auth.

2-2756. Kaufmann, Godfrey F. PETROLEUM DEVELOPMENTS IN FAR EAST IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 7, p. 1179-1204, 5 maps, 23 tables, July 1960.

The Far East remains an outlet for crude oil which is potentially in excess in other major oil-producing areas. Competition for the market in Japan, in particular, may become very keen in the near future. Production from Japan's newly discovered oil in the Persian Gulf will no doubt cut into the sales in Japan of other Middle East producers. Russia will compete with noncommunist producing areas in supplying some Far East markets. Oil production in communist China may soon exceed the indigenous requirements and such excess crude oil will be available for export. China's largest oil refinery went on stream during 1959, at Lanchow, Kansu province. Gas also will cut into the oil markets of the Far East. Japan is expanding its gas production and brought in large gas reserves during 1959. All producing areas of the Far East showed an increase in crude oil production during 1959, with the exception of Java, Netherlands New Guinea, and perhaps Sakhalin. The total oil production in the Far East in 1959 was 221,662,802 bbls. compared with 190,375,439 bbls. in 1958, a gain of more than 30 million bbls., about 18%. Two small producers were drilled on the island of Cebu in the Philippines to be rated as the first commercial oil wells in the Philippine Islands.--Auth.

2-2757. Kornfeld, Joseph A. FIRST COMMERCIAL OIL DISCOVERY FOR THE PHILIPPINE ISLANDS: Petroleum Engineer, v. 32, no. 4, p. B-101, B-105, B-110, maps, sec., Apr. 1960.

A successful drill stem test near Toledo on W. coast of Cebu Island marks the first possible commercial oil discovery after 63 years of sporadic exploration. The principal folds throughout the region may be resurveyed for deep drilling. Gas and oil were found between 1,091 and 1,284 ft. The apparent discovery lies near 8 shallow holes drilled to about 1,000 ft.--Worldwide Oil and Gas Abstracts, v. 5, no. 3, p. 25-26, May-June 1960, abs. 53-8-17.

2-2758. Hedberg, Hollis D., and John D. Moody. PETROLEUM DEVELOPMENTS IN AFRICA IN 1959: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 7, p. 1102-1143, 13 maps, tables, July 1960.

Petroleum production in Africa in 1959 attained a new all-time high of 41,472,057 bbls., representing an increase of 36% over the previous year. This increase came largely from Algerian Sahara, Nigeria, and Gabon. Egypt continues to be the leading producing country but showed a slight decrease as compared with 1958.

One hundred eighty-five wildcat wells were completed in Africa in 1959, of which 26% were successful. Of new discoveries, 14 were made in Libya, 9 in Nigeria, 7 in Algerian Sahara, 2 in Angola, and one each in Egypt, Cameroun, and Senegal. Explora-

tory wells were completed but without success in Congo, Ivory Coast, Kenya, Madagascar, Morocco, Somalia, British Somaliland, Tanganyika, Tunisia, and Zanzibar. Two hundred twenty-two development wells were completed during the year, of which 86% were producers. More than half of all development wells were in Algerian Sahara. A total of 2,984,461 ft. of hole was drilled in Africa in 1959, an increase of 35% over 1958, and at the end of the year 106 rigs were in operation.

Geological-geophysical exploratory work was most extensive in Libya and Algeria. Party-months of various types of exploratory work for the whole of Africa were as follows: surface geology - 710, seismograph - 896, gravity - 125, ground magnetometer - 35, airborne magnetometer - 12, structure drill - 27. Concession activity was particularly great in Algeria and Libya and in Spanish Sahara.--Auth.

2-2759. Lapparent, C. de, and P. Albert. HASSI-MESSAOUD-SAHARAN OIL GIANT: World Petroleum, v. 31, no. 6, p. 43-46, map, secs., June 1960.

Reserves in the mammoth French Saharan oil field of Hassi Messaoud are estimated at 19 million barrels. The entire reservoir, located at an average depth of 10,000 ft., is siliceous, cemented, quartzitic sandstone of Cambrian age.--Worldwide Oil and Gas Abstracts, v. 5, no. 4, p. 21, July-Aug. 1960, abs. 54-8-20.

2-2760. MALI OPENS SECOND FRENCH SAHARA: World Petroleum, v. 31, no. 4, p. 64, 65, 104, Apr. 1960.

A new sedimentary area has been opened for exploration in the new Mali Federation in western Africa. Two states, Senegal and Sudan, comprise the area which is largely untested, but the scene of many oil seeps. Three principal sedimentary basins are located in the area - the Cretaceous-Tertiary basin of Senegal, the Paleozoic basin of western and central Sudan, and the Cretaceous-Eocene formations of the eastern Sudan.--Worldwide Oil and Gas Abstracts, v. 5, no. 3, p. 26, May-June 1960, abs. 58-8-31.

2-2761. COSTLY OIL SEARCH IN EAST AFRICA: Petroleum Engineer, v. 32, no. 6, p. B-31, June 1960.

A short description of the costs and results of searching for oil in E. Africa. Aerial surveys have been made, also marine surveys. Results in many cases have been disappointing.--Worldwide Oil and Gas Abstracts, v. 5, no. 4, p. 20, July-Aug. 1960, abs. 54-8-7.

14. ENGINEERING GEOLOGY

2-2762. Davidson, Donald Thomas, Chalmer J. Roy and others. THE GEOLOGY AND ENGINEERING CHARACTERISTICS OF SOME ALASKAN SOILS: Iowa State Univ., Eng. Expt. Sta., Bull. 186, 149 p., illus., maps, graphs, Dec. 1959, refs.

This bulletin contains 6 separate reports which present the results of 4 years of research on some Alaskan soils, by 11 men. The reports are modified versions of those submitted as a final report to the U.S. Office of Naval Research which supported the investigations. The 6 papers are separately abstracted below in the order in which they appear in the bulletin.

2-2763. Stump, Richard Webster, and others. SILT DEPOSITS IN THE MATANUSKA VALLEY (In: Davidson, Donald Thomas, and others. The Geology and Engineering Characteristics of Some Alaskan Soils: Iowa State Univ., Eng. Expt. Sta., Bull. 186, p. 3-32, 23 figs. incl. illus., maps, profiles, graphs, 5 tables, Dec. 1959) 38 refs.

This study concerns the geologic engineering investigation of Matanuska Valley silts, silt relationships, and geomorphology. The silts occur as blanket deposits up to 23 ft. thick on a variety of landforms in the valley. The silts consist mostly of rock fragments of slate, phyllite and graywacke. Quartz grains are abundant and chlorite is the dominant clay mineral present. The geomorphic relationships indicate that the silts were deposited in a short time during a complex sequence of late Quaternary events. The authors believe the most likely environment of deposition was either lacustrine or eolian but point out that the traditional eolian concept will not explain all the relationships observed.

The silts would make adequate subgrade for moderate thicknesses of highway pavement construction. Plasticity data indicate the silt is not suitable as a clay binder in mechanical stabilization. Bearing values indicate that with suitable admixtures it could be stabilized.--J. Lemish.

2-2764. Lindholm, Gerald Franklin, and others. SILTS NEAR BIG DELTA AND FAIRBANKS (In: Davidson, Donald Thomas, and others. The Geology and Engineering Characteristics of Some Alaskan Soils: Iowa State Univ., Eng. Expt. Sta., Bull. 186, p. 33-70, 34 figs. incl. illus., maps, graphs, 9 tables, Dec. 1959) 37 refs.

This investigation was conducted to study geologic and engineering properties of silts in the vicinities of Big Delta and Fairbanks and to attempt to relate these properties to a distribution pattern and geomorphology. In the Big Delta area the silts occur as deposits from inches to 58 ft. thick on a variety of landforms formed during and since Quaternary glaciation. The silts are most prominent on moraines and outwash deposits and are thickest adjacent to the Delta River. They are believed to be locally derived and represent alluvial and eolian deposition although no singular universal origin is applicable. The silts consist mostly of quartz, plagioclase and muscovite; and the clay minerals in order of abundance are illite-muscovite, kaolinite, and chlorite. Engineering properties indicate the silts have bearing values less than Matanuska Valley silts. Plasticity data indicate they lack sufficient cohesion for use as a binder material.

The silts near Fairbanks cover a large portion of the upland surfaces on the N. side of the Tanana river in thicknesses up to 180 ft. These silts are less micaceous, finer textured and more uniform in color than the Big Delta silts. Quartz, plagioclase, and muscovite are the dominant silt-sized minerals present and montmorillonite is the dominant clay. Engineering properties indicate the silts will form fair to very poor sub-grade material. Low plasticity values indicate they are unsuitable as binder material.--J. Lemish.

2-2765. Mathews, A.C., and others. TRAFFICABILITY OF ALASKAN SILTS (In: Davidson, Donald Thomas, and others. The Geology and Engineering Characteristics of Some Alaskan Soils: Iowa State Univ., Eng. Expt. Sta., Bull. 186, p. 71-85, 16 figs. incl. illus., maps, graphs, 2 tables, Dec. 1959) 21 refs.

An investigation of trafficability, defined as the ability of a soil to support traffic and measured by the Corps of Engineers cone penetrometer, was carried out in the Matanuska Valley, Fairbanks, and Big Delta areas. In the Matanuska Valley, trafficability is increased in cultivated or clear areas due to consolidation of the silt. Near the Matanuska River it is better in silt areas than in upland sand deposits. Tests in the Fairbanks area were inconclusive but trafficability is predicted to be similar to that in the Matanuska Valley. In the Big Delta area the results were similar to those observed in the Matanuska Valley.--J. Lemish.

2-2766. Blank, H.L., and others. MILITARY TRAFFICABILITY OF SOILS IN THE MATANUSKA VALLEY (In: Davidson, Donald Thomas, and others. The Geology and Engineering Characteristics of Some Alaskan Soils: Iowa State Univ., Eng. Expt. Sta., Bull. 186, p. 87-99, 11 figs. incl. illus., map, graphs, Dec. 1959) 20 refs.

Detailed trafficability studies of the Matanuska Valley were extended to include its relationship to climate, topography, vegetation, and soils of the area. A suggested procedure for tactical trafficability mapping is presented.--J. Lemish.

2-2767. Carlson, P.R., and others. GEOLOGY AND MECHANICAL STABILIZATION OF CENOZOIC SEDIMENTS NEAR POINT BARROW (In: Davidson, Donald Thomas, and others. The Geology and Engineering Characteristics of Some Alaskan Soils: Iowa State Univ., Eng. Expt. Sta., Bull. 186, p. 101-128, 30 figs. incl. illus., maps, graphs, 10 tables, Dec. 1959) 46 refs.

This study undertaken to correlate geological and engineering data in order to find local soil materials for road and airfield construction includes a discussion of the climate, inaccessibility, geology, and geomorphology of the region which accompanies a report on test results obtained from bulk samples representative of the Barrow area. It was found that modern and ancient beach deposits make the best sub-grade materials and that tundra materials would make a poor sub-grade. Coarse ice-rafted gravels would be the best sub-base material. A base course could be built from lake silts mixed with ice-rafted gravels. Materials for sub-grade and sub-base are fairly common in the area.--J. Lemish.

2-2768. O'Sullivan, John Blandford, and others. CRUDE OIL FOR STABILIZATION OF SOIL MATERIALS AT POINT BARROW (In: Davidson, Donald Thomas, and others. The Geology and Engineering Characteristics of Some Alaskan Soils: Iowa State Univ., Eng. Expt. Sta., Bull. 186, p. 129-149, 14 graphs, 11 tables, Dec. 1959) 28 refs.

The study of bituminous stabilization using local crude oil was initiated in order to obtain a better base course material in road, sidewalk, or airfield construction and also to attempt to find a waterproof, wear resistant surface course. Stabilization tests using natural crude oil directly were unsuccessful. Crude oil residues were utilized to prepare asphalts by blowing. Various tests utilizing hot and cold mixes with various combinations of soils and materials were conducted.

It was found that blown asphalt from locally derived crude oil can be used in bituminous stabilization of base and surface courses. Satisfactory dense graded and semi-open graded asphaltic concrete as well as sheet asphalt could be prepared from local materials. Although flexible pavements can be readily designed for beach areas with good sub-grade stability, flexible pavements in tundra areas are possible only when measures are taken to prevent thawing of the permafrost.--J. Lemish.

15. MISCELLANEOUS

2-2769. Gamow, George. BIOGRAPHY OF THE EARTH. ITS PAST, PRESENT, AND FUTURE: rev. ed., 242 p., 58 figs. incl. illus., maps, charts, diags., New York, Viking Press, 1959.

A revised edition of a popular accounting of the origin of the earth, moon, and planets, and the earth's subsequent geologic history, first published in 1941. The revision incorporates the most recent modified Kant-Laplace "parthenogenetic" nebular hypothesis of the origin of planets.--M. Russell.

2-2770. Waters, Frank. THE CANYON: Arizona Highways, v. 36, no. 6, p. 12-14, 23-27, 12 illus., June 1960.

Reprint of a chapter from the author's book "The Colorado" published in 1946. It is a popular recounting of the history, appeal, impressions, geography, and geology of the Grand Canyon of the Colorado. The geological description stresses the stratigraphic aspects; it includes names, thicknesses, age, and gross descriptions of the major units.--M. Russell.

2-2771. Bonney, Orrin H., and Lorraine G. Bonney. GUIDE TO THE WYOMING MOUNTAINS AND WILDERNESS AREAS: 389 p., 97 illus., 22 maps, Denver, Colorado, Sage Books, 1960, refs.

A catalogue and climber's guide to the mountains of Wyoming. Detailed information on climbing routes and methods is given. Organization of the book is basically by individual mountain range for which there is included general information on name, history, geology, forests, and hunting and fishing. A brief section on mineral- and fossil-collecting localities is included.--M. Russell.

2-2772. Cheesman, R.L. GEOLOGICAL SURVEY WORK IN SASKATCHEWAN, 1959: Can. Mining Jour., v. 81, no. 4, p. 71-73, map, Apr. 1960.

Geological activities of the Mines Branch of the Saskatchewan Dept. of Mineral Resources during 1959 are reviewed. Geologic mapping results are described in the Wapus Bay, Oliver Lake, Otter Lake-Trout Lake, Clut Lake, and Tantano Lake areas. There are first indications that major stratigraphic units can be delineated in the Precambrian of Saskatchewan and that a division between geological subprovinces will be possible.

The procedure of selecting areas to be mapped in

the extensive Saskatchewan Precambrian area and the assigning of mapping priorities to specific areas is discussed.--W.C. Peters.

2-2773. Puerto Rico, University, Institute of Caribbean Studies. STATUS OF GEOLOGICAL RESEARCH IN THE CARIBBEAN, No. 1, Sept. 1959, No. 2, March 1960, compiled by John D. Weaver: 19 p., 13 p., Mayaguez, College of Agriculture and Mechanic Arts, 1959- in progress.

A twice-yearly compilation arranged geographically and including the following areas: Caribbean region (general), Central America, Colombia, Cuba, Dominican Republic, the Guianas, Jamaica, Mexico, Panama and Canal Zone, Puerto Rico, Trinidad, Venezuela, Virgin Islands and Lesser Antilles. The brief reports on research are listed alphabetically by the name of the research worker.

2-2774. Karo, H. Arnold. 1960 ANTARCTIC RESEARCH PROGRAM: Surveying & Mapping, v. 20, no. 2, p. 203-206, illus., June 1960.

Plans for U.S. scientific research in the Antarctic for 1960 include a total of 29 projects announced to date. The preparation of large-scale topographic maps and establishment of geodetic control points has high priority. A program of research in geomagnetism will provide data on temporal changes in the earth's magnetic field. Revision of the American Geographical Society's 1:3,000,000-scale map of the Antarctic and completion of an atlas are planned. Two geologists will accompany oversnow traverses to make seismic, gravity, magnetic, and glaciological measurements.--M. Russell.

2-2775. Coats, Robert R. STEREOSCOPIC-PAIR PROJECTION OF AERIAL PHOTOGRAPHS IN MAP COMPILATION: Geol. Soc. America, Bull., v. 71, no. 5, p. 629-630, May 1960.

This note describes 2 methods for transferring information from stereographic pairs of aerial photographs to topographic base maps. Both methods require the use of a variable-ratio reflecting projector, of the Saltzmann type, and both are useful only to persons capable of naked-eye stereoscopy. The methods make the stereoscopic model appear nearly coincident with the topographic map, so that the lines on the map appear as if drawn on a relief model.--B.W. Pipkin.

AUTHOR INDEX